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T H E
DIARIAN MISCELLANY:

CONSISTING OF

All the Useful and Entertaining Parts, both Mathematical and Poetical, extracted from the

L A D I E S' D I A R Y,

From the beginning of that work in the year 1704,
down to the end of the year 1773.

With many additional

SOLUTIONS and IMPROVEMENTS.

In five Volumes.

V O L. I.

By ¹⁷¹⁵ **CHA. HUTTON, F. R. S.**
Professor of Mathematics in the Royal Military Academy.

L O N D O N:

Printed for G. ROBINSON and R. BALDWIN in Paternoster Row, 1775.

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P R E F A C E.

THE late ingenious Mr. Thomas Simpson, who was one of the worthy compilers of the original Ladies' Diary, speaking of the merit of that little book, says "that for upwards of half a century, this small performance, sent abroad in the poor dress of an almanac (and that under a title, not calculated to raise the highest expectations) has contributed more to the study and improvement of the mathematics, than half the books professedly written on the subject. The most celebrated authors now among us, have contributed to promote the reputation of the Ladies' Diary; and the compiler thinks he may, without any offence to truth, venture to pronounce, that the mathematical part (at least) is, at this time, greatly superior to every attempt to imitate it, and not below the notice of the best judges."

On this head I shall not enlarge, as the merit of this little annual performance is too well known and acknowledged, to need any more particular declarations of it in this place. I shall therefore only employ a few lines, by way of preface, in pointing out the motive for this publication of the diaries collected, with the plan on which it has been completed.

The extreme scarcity of the more early numbers of the diary, with the importance of the many curious particulars of which the whole consists, had rendered a collection of the whole almost invaluable. And as it had long been found almost impossible to collect together any number of complete sets of them, it was therefore earnestly desired that, from some one entire collection of them, a republication might be made of the most useful and entertaining parts extracted from the whole. In consequence, several attempts were at different times made, by some spirited friends of the work, to collect a complete set, and to furnish the public with an edition of such extracts. Unluckily,

however, from various causes, their attempts generally failed on being carried into execution. Among the rest, the editor of this collection, with much trouble at last completed an entire set, with the same laudable view; and by the kind assistance of some friends, and the generous encouragement of the public, he has been enabled to bring out this edition of the so long desired work, from the beginning of it in the year 1704 to the end of the year 1773, including a period of 70 years.

Being aware of the difficulties attending the proper execution of this business, both with regard to the natural abstruseness and intricacy of many parts of the work, and to the ascertaining of the best plan and method of conducting it; before I began to print any part of the book, I collected together all the assistance, in both respects, from many ingenious and learned gentlemen, who were well acquainted with the nature of the work, by whom I was supplied with several other corrected solutions, and from all their opinions concerning the plan or manner of printing, &c. I have been enabled to extract one which seemed to be the least exceptionable of any, and according to it the work has been at length completed. Of that plan I shall now give a short account.

Agreeably to the wishes of most people, the grand out-line resolved on was, a republication of all or most part of the useful and entertaining articles of the work, viz. all the mathematical parts, and almost all the poetical or enigmatical ones. In two volumes therefore I have included these last-mentioned parts; having omitted only some small things of least value, as rebusses and paradoxes, with some few of the less elegant solutions of the enigmas where they were cumbersomely numerous. And in three volumes are included all the mathematics, both questions, solutions, tracts, and eclipses. And here solutions have been carefully supplied where they were wanted, the erroneous ones corrected, and the obscure ones explained and elucidated; also to the annual calculations of eclipses are added accounts of the observations made
of

P R E F A C E.

of the same eclipses collected from various publications, which it was thought might be of use in shewing the degree of nearness in the tables from which the calculations had been made, when the computers were such as might be depended on: all which additions are printed in a smaller type by way of notes at the bottoms of the pages; so that the text or work itself is regularly disposed without any interruption from them. All the parts are printed after the order of their dates; by which disposition it very readily appears what each year's original diary consisted of, and from which it might again be easily recomposed and thrown into its original form. The running titles at the tops of the pages are so contrived as to shew both the particular subject there treated on, the year's diary to which it belongs, the number of years it is from the beginning of the work, and the author or compiler of the work for that year. From these titles it appears that the 70 years include a succession of five different authors, viz. Mr. John Tipper, the original projector and beginner of the work, from the year 1704 to 1713 inclusive; Mr. Henry Beighton from 1714 to 1744; Cap. Rob. Heath from 1745 to 1753; Mr. Tho. Simpson from 1754 to 1760; and lastly Mr. Edw. Rollinson from 1761 till his death in 1773. These are all the nominal authors that have conducted the work during the different years of its existence: but besides them there were some other persons who have been at different times partly concerned with them in its management; so it is said that for some years before the death of Mr. Beighton, the mathematical parts were composed by his friend Mr. Ant. Thacker, as being a better mathematician; and that for some time before and after his death, the enigmatical parts were managed by his amiable wife.

Of all these personages I had thought to have given here a short history, as a proper appendage to this complete edition of a work in which they deservedly acquired so much honour; but after many fruitless endeavours to procure proper materials for such memoirs, I have been at last obliged to relinquish that favourite

favourite design for want of sufficient papers relating to the lives of the more early compilers.

It may be perhaps not unnecessary to observe that, in a few sheets near the beginning of this work, the original orthography and other peculiarities of language are retained, where they appeared to have proceeded from design; but that in the rest of the work throughout, the obsolete spelling and grammatical inaccuracies are mostly altered agreeably to the present state of our language; and the proposing of a question in bad verse, has, in one or two instances which seemed to require it, been turned into plain prose.

Finally, at the end of the last volume of poetry is added a list of the subjects of all the enigmas in chronological order. And at the end of the last volume of mathematics, an alphabetical list of all the diary writers, with the questions subjoined which each proposed and answered; as also, an appendix, containing additional improved solutions to some few of the questions, with corrections of the material errors which had escaped notice in the printing, and which might affect the sense of the reading. Other smaller inaccuracies are, by the editor, submitted to the indulgence of the candid reader.

T H E
M A T H E M A T I C A L P A R T S
O F T H E
L A D I E S' D I A R I E S.

1705

Of the Motions of the Sun and Moon.

TH E R E is is nothing more strange and suprising to some persons, than the various motions and appearances of the sun and moon. To see, for instance, the sun rise sometimes due east, and set due west, at other times to see him rise and set a great way more northward, and at half a year after a great way more south. To observe the days to increase one time in the year a whole hour in 15 days, and at another time not above 10 minutes in the same space of time, and sometimes to stand at a stay. Likewise to see the moon sometimes to rise and set not above a quarter of an hour's distance from her rising or setting the precedent night, and at another time she will be an hour and an half distance of time from her rising or setting the precedent night. To see her sometimes full, at other times gibbous, after that horned, then again wholly to disappear, sometimes to be eclipsed in part, at other times totally eclipsed: These appearances are very strange and unaccountable to most people; but to give my fair reader some insight into these mysteries, I shall endeavour to explain the motions of these two great lamps of heaven, and that by an instrument very familiar to the female sex; I mean by the rim of an ordinary spinning-wheel.

Suppose then the outward or larger circle in the following figure, to be the farther side or edge of the wheel's rim; the inward or least circle, the hither edge thereof; Suppose the middle circle to be a line drawn round the middle of it, or

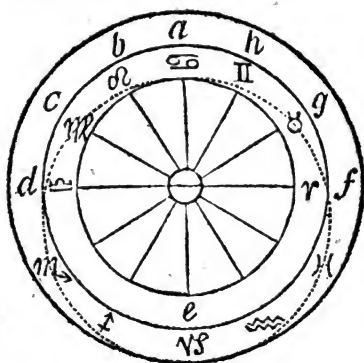
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else

else if you please the wheelstring tied close quite round the middle of the rim: and tho' these three circles are in the figure one bigger than another, because it could not be drawn otherwise upon paper, yet you must imagine them all equal, and that this is the upper or outside of the rim. (As for the pricked circle we shall consider that presently.)

Now let us suppose a fly was in the middle and top of the rim at (*a*,) and it run with a regular and even motion towards (*b*, *c*, *d*, *e*, *f*,) and so on till it run quite round the rim, in just the space of a minute. Now if while, at the same time, the fly at (*a*) begins its motion towards (*b*, *c*, *d*, &c.) you turn the wheel about the contrary way just four times in a minute, namely, towards (*b*, *g*, *f*, &c.) as you do in spinning. It then plainly follows, that the fly will go about once whilst the wheel runs the other way four times, so that when the rim is turned once about, the fly will be advanced one quarter of the rim and be at (*d*,) when the rim has been turned twice about, the fly will be half way at (*e*,) when thrice she will be at (*f*,) when four times they meet again exactly at (*a*,).

Again, if when the fly began to move at (*a*) and go to the left-hand, you began at the same time to move the wheel-rim towards the right-hand or contrary way: And instead of turning it about four times, you had turned it twelve times about in the same time as the fly had gone about once. (It matters not whether it be in a minute, or hour, or day, or month, or any other time, provided it be the



same time exactly, that the fly moves once about, the rim moves twelve times about the contrary way.) Upon this supposition, the fly, at the end of the first turning about of the rim, will be advanced to (*b*), a twelfth part of the circumference; at the end of the second turning about, it would be advanced to (*c*), another twelfth part; at the end of the third revolution, the fly would be advanced to (*d*), a third twelfth part, or quarter of the circle; and so likewise at the end of six revolutions of the wheel, the fly would be advanced to (*e*), half way, and at the end of twelve returns it would come to (*a*) again; the fly constantly and perpetually advancing in its slow motion one way, as the wheel did its swifter motion the other

other way. And the like you may conceive if the wheel made 30, 50, 100, 365, 500, or any other number of revolutions at the same time as the fly did one, it would necessarily fall out, that at the end of that respective number, the fly would come to its place again, from whence it first set out, and it matters not whether it began to move at (*a*), or at any other place at *b*, *c*, *e*, &c.

Let us once more suppose another wheelstring ty'd about the rim of the wheel, the upper part at *B* to touch the edge of the rim at the side next to you, the under part of the wheelstring to touch the edge of the rim farthest from you at *V*, and then it would cross the wheelstring in the middle of the rim just half way between top and bottom on each side at (*d*) and (*f*), (or which is all one at *∩* and *∪*.) And now if you suppose the fly to begin to move about the second wheelstring, tied cross-ways over the first represented by the prick'd circle from *B* to *N* *∩*, and so round to *B* again; and whilst the fly moved once round, the wheel was turned the contrary way any number of times, (suppose 4 or 12 times) it would finish its revolutions just as is before declared, but with some difference to its former motion, as shall presently appear.

JUST thus is the motion of the sun, moon, and planets in the heavens. For the sun and stars go by a * proper motion of their own from west to east, as did the fly; and the whole heavens with sun, moon, and stars, are carried the contrary way as the hand turned about the wheel; the sun moves so slow, that while he goes once about in his own course, along the prick'd line one way, the heavens are carried about 365 times the contrary way, and then he comes to the same place again: But the moon is swifter in her motion, and runs round from west to east, whilst the whole heavens is whirled about 27 times and a quarter, or (which is all one) in 27 days and a quarter.

But from this motion of the sun round the prick'd circle, arises several appearances carefully to be observ'd, because it shews the reason of many of those particulars I at first mentioned, viz. Let us suppose the sun in *B* going onward in his own slow motion towards *N*, and so on to *∩* *m*, &c. And the whole heavens carried about the contrary way once a day. It follows, that upon that day, which is about the † 11th of June, he is nearest over our heads, and maketh the longest

B 2

day

* Our author is not here to be understood to mean an absolute or real motion; he means only the apparent motion arising from the real motion of the earth.

† Our author having written before the change of the style, all his times must be understood according to the old style, and will require 11 days added to adapt them to the new.

day with us, and then he rises and sets very much towards the north, and the line which he maketh in the heavens that day, is called the tropick of Cancer.

In a quarter of a year after, he will be got along the prick'd line to α , and then the days and nights are of equal length; and he rises just in the east and sets in the west, and the line which he maketh in the very midst of heaven, is called the equinoctial circle, and this happens about the 12th of September, [and just so it will be half a year after when he comes to γ , which will be about the 10th of March.]

In a quarter of a year after, he is at α , he will come down by degrees to ψ , and then he is farthest from us, which happens about the 10th of December, and then the circle he seems to make in the heavens that day, is called the tropick of Capricorn, and then he rises and sets very much towards the south.

The prick'd line, in which the sun is supposed to pass, is called the ecliptick, because there can be no eclipse but the moon must be in or very near this circle; but the sun never goes out of it.

The whole breadth between the outward and inward circles (which two must be imagined equal) is called the zodiack, which is the only circle in the heavens that hath any breadth. The distance of any star from the ecliptick or prick'd circle, is called the star's latitude, (either north or south as it happens to be either north or south from the circle) and the distance of any star from the middle circle or equinoctial, is called its declination, (north or south as before.)

Again, when the sun is near the tropicks, as when he moves from Π to α , he moves just against the motion of heavens, and so is swiftest in his motion, and makes a greater speed toward's his journey's end; but then the length of the day and declination (or distance from the middle circle) is but little alter'd: But when he moves near the equinoctial, as from α to γ , then he runs obliquely or crosses the heaven, and then the days and declination increase or decrease evry considerably, but he moves but slowly towards his journey's end, because he crosses the heavens from one side of the middle to the other; and this is one of the reasons why from noon to noon is not exactly 24 hours, but sometimes more and sometimes less.

As the sun thus runs in a circle of his own from west to east, in one year, so doth the moon in a circle of her own in 27 days and a quarter the same way; and the moon's circle crosses the sun's circle in two points, just as the sun's circle crosses the equinoctial in γ and α : But the distance of the moon's circle, from the sun's, in the widest place, is not quite a fourth part the distance of the sun's circle from the equinoctial. But of this and of the various appearances of the moon, I have not now room to proceed.

AN

AN ECLIPSE of the sun is caused by the moon, who is a dark body, being interposed or placed between the sun and us, and this happens when the moon is near one of the points where her circle crosses the ecliptick or sun's circle. Thus, suppose the earth, whereon we live, to be in the middle of the precedent figure at \ominus , the sun at (f) and the moon at \vee . Here because the moon at \vee interposes, it takes away the light of the sun from us; such will be the position of the sun and moon upon May-day next year, 1706. It will begin to be darkened at 9 minutes after 8 in the morning, but at 17 minutes after 9 it will be the most darkened, when near 10 parts of 12 of the sun's body will be obscured, and he will appear like the first appearances of the new moon. This will be a great eclipse; we had a greater in 1654, but a much greater in the year 1652, when the whole body of the sun, within less than 16 minutes, was obscured.

An eclipse of the moon is caused by the sun's being on one side the earth, and the moon on the other, (near the ecliptick) and the shadow of the earth falls upon the moon, (from whence she hath her light.) As suppose the sun in \odot , the earth in \ominus , the moon in (f) , here the light of the sun at \odot , falling upon the earth at \ominus , takes away the light of the moon at (f) , who otherwise would reflect her light back upon us as at other times.

There are a great many admirable conclusions to be drawn from the consideration of eclipses, but more of that hereafter.

1706

Of the nature of an Eclipse of the Sun, and of that great Eclipse which will happen upon May-day this present year, with the exact time of its beginning, middle, and end; recommended to the observation of the curious.

THE mind of man hath a strange propensity, and eager thirst after knowledge; nor will he spare for pains to gratifie his curiosity; he will traverse mountains, valleys, woods and desarts; he will plunge thorough the vast and raging ocean; he will penetrate into the bowels and caverns of the earth; nay, some will not stick to go to Hell beneath, to compass know-

ledge. But of all the objects of our thoughts, there is none more noble, or give a greater satisfaction to the mind, than the contemplation of the heavenly phenomena, the motions, periodical revolutions, appulses, and other passions and effects of the fixed stars and planets. This made the poet cry out,

Ye sacred muses ! with whose beauty fir'd,
My soul is ravish'd, and my brain inspir'd;
Give me the ways of wand'ring stars to know:
The depth of heav'n above, and earth below?
Why flowing tides prevail upon the main:
And in what dark recess they shrink again?
What shakes the solid earth? what cause delays
The summer nights, and shortens winter days?
Teach me th' various labours of the moon,
And whence proceed th' eclipses of the sun?

DRYDEN.

Last year I gave you an account of the true motion of the sun and moon about the heavens, with the various appearances caused thereby, such as the increase and decrease of the days and nights, of their rising and setting, and of their eclipses; which things being rightly conceived, will be of great advantage towards the ealie apprehending the following discourse of the eclipse of the sun, which I now the rather undertake, because there will be a very great eclipse upon May-day next, the like not having been these fifty years past.

Now an eclipse of the sun is when the moon (who is a dark opake body) interposes or happens to come between the sun and us, and shades or hides the light of the sun from us, and this is sometimes wholly, and then it is called a total eclipse; and sometimes but in part, and then it is called a partile eclipse.

To conceive aright the true nature of the sun's eclipse, you may provide or imagine a large hoop of two yards diameter or widest breadth, cut off a third part from the rest, and nail to the middle of this piece a stick of just a yard in length, that it may be like a cross bow without a string; and as you see in the lower part of figure 1. where f, g, c, b, i , represents the bow or third part of the hoop, and K, c , the stick. Suppose now you saw (or imagined you saw) a very fair rainbow painted on the clouds (as is also in figure 1. the upper part) take your hoop, and holding the end of the stick at K to your eye, turn the hoop to the rainbow, and hold it so that the hoop may seem to cover the rainbow, and hide it from your sight. Being thus fixed, turn the stick (to which the hoop is fastened) a little, that the hoop may cross, or seem to cross, the rainbow, the half f, g, c , being above it, and c, b, i , below it, as you may see in figure 2. where a, b, c, d, e , represents again the rainbow, and f, g, c, b, i , the hoop, and \ominus at K represents the eye, (but here the stick affixed to the hoop is wanting.)

NOW

Now if you join, or suppose to join, the other part of the hoop to this, to compleat the circle, and if you imagine the rainbow to be completely round, and about 400 yards distance every way from your eye, this will represent to your fancy pretty near the true paths or circles wherein the sun or moon move; and also the proportions that their distances bear to one another.

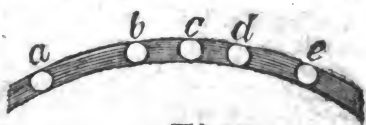
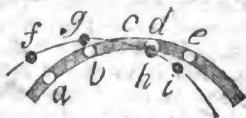


Fig. 1



K

Fig 2. \ominus_K 

crossing

* This is the Synodical month, or time between one lunation and another, and is 2 days and a quarter longer than the periodical month mentioned in the last year, page 3; this excess is caused by the motion of the earth (and moon) almost a whole sign during the time of the periodical month, and the moon must continue to revolve for this additional time to bring her to a conjunction again.

crossing is called the node, or dragon's head. Now had the circle in the figures been compleatly round, it would cross again on the other side, which is called the other node, or dragon's tail; the angle it makes at the crossing f, c, a , or e, c, i , fig. 2. is about 5 degrees.

These things being rightly conceived, it follows:

1. If the circle of the moon had been just under the circle of the sun, then at every conjunction, or new moon, there would be an eclipse of the sun, (and at every opposition, or full moon, there would be an eclipse of the moon.)

2. But the circle of the moon crossing that of the sun, it follows there can be no eclipse of the sun, but when the moon is in or near her nodes, or places of crossing, as you may plainly perceive by the figures. For suppose the moon in f , (in either fig.) the sun in a , and the eye at \ominus (or K ,) here the moon is above the sun, or higher than he, and therefore cannot hinder its light from us: if the moon had been at i , and the sun at e , the same thing would happen, for then the moon is lower than the sun, and so eclipses him not: if the moon meets the sun when she is near her node, suppose at g , and the sun at b , here she passeth but a little above him, and so he escapes an eclipse. But if when the moon was at b , the sun was at d , here the moon would pass between the sun and \ominus , and appear half eclipsed; but if the moon was in c , the very point where her circle crosses that of the sun, and suppose the sun at the same time to be at c also, then would the sun be totally eclipsed.

From whence it is plain, that whenever there is a conjunction, (or meeting of the sun and moon, (if it comes within the bounds of an eclipse) then earer the moon is to her node, the greater will be the eclipse of the sun, and the farther she is from it, the smaller will be the eclipse; but when she is so far from her node, or place where the circle crosses, that half the apparent breadth of the sun, and half the breadth of the moon will not reach to touch one another, then there will be no eclipse for that conjunction; but if the conjunction be when the moon is a great way farther from her node, (as it mostly happens) then most certainly there can be no eclipse for that time.

Upon May-day next, the sun, 'tis true, will not be totally eclipsed, but the centers of the sun and moon will be but 5 minutes, very near, distance asunder, and will be the greatest eclipse that hath happened these 50 or 60 years in our island; the time of the beginning, middle, and end thereof, I will give you from the calculation of one of the greatest astronomers of this, or perhaps of all former ages, as also the parts of the globe the shadow will pass over. (See fig. 3.)

The middle time of the eclipse of the sun, that happens
May

May the first, 1706, will be in the meridian of London at 9 ho. 42 min. in the morning.*

The visible beginning of the eclipse at London at 8 ho. 23 min.

The end at 10 ho. 37 min. and an half. At 9 ho. 30 min. about the middle of the eclipse, the distance of the centers of the sun and moon will be 5 minutes very near, and so will be of almost 10 digits and an half from the south.

The shadow begins to enter the discus of the whole earth almost in the mid way between the Hesperiden and Caribee islands, then tending into the east, leaves the Canary islands upon the left, and passes through the kingdom of Morocco. Hence coasting the eastern shore of almost all Spain, it reaches Provence in France, near the port of Thoulon. Whence the shadow passing forward, after being spread through Piemont, and the country of Milan, describes the borders of Bavaria and Austria, and then passing over Bohemia and Silesia, overshadows almost half Poland and Lithuania. Hence being carried by the regions of Moscovy and Siberia, it slips into unknown Tartary, and lastly above China it quits the earth, the sun being there totally obscured in its setting. But where the centers of the sun and moon fall in together, the darkness will be like that of night, and the stars will be visible for the space of the one four and twentieth part of an hour.

How to behold an eclipse of the Sun without hurt to the eyes.
By Mr Pond.

TAKE a burning glass, such as men use to light tobacco with in the sun; or a spectacle glass that is thick in the middle, such as is for the eldest sight, and hold this glass in the sun as if you would burn through it a pasteboard, or white paper book, or such-like; draw the glass from the board or book twice as far as you do to burn with it: so by direct holding it nearer or farther, as you shall see best, you may behold upon your board, paper, or book, the round body of the sun, and how the moon passeth between the glass and the sun, during the whole eclipse.

This may'st thou practice before the time of an eclipse, wherein thou shalt discern any cloud passing under the sun; or by another putting or holding a bullet or his finger's end betwixt the sun and the glass, at such time (the sun shining) as thou holdest the glass, as before thou art taught.

I shall

* These times are a few minutes different from those given by the author last year, page 5. The observed times I shall give afterwards along with the other eclipses.

I shall in my next give an account of the eclipse of the moon, and of several admirable conclusions that are to be drawn from the consideration of the eclipses of both the great luminaries.

1707

Of the Phases and Eclipses of the Moon.

HAVING in my last given you an account of the nature of an eclipse of the sun, as also of that great eclipse on May-day, it was my intentions to have been very nice in the observation of it, by casting its species upon paper by a telescope, and by six concentric circles equidistant from their center, to observe the digits eclipsed from time to time, and to have corrected the clock by calculation from the sun's altitude, and to have inserted my observations in this place; but the unfavourableness of the weather spoiled all my designs: however sometime thro' the clouds the eclipse was perceived, and, as near as could be ghesed, at the very same time, and in the same appearance exactly as was there set down, and as by the figure of it was represented; the same side being enlightened, and the sun appearing not much unlike a new moon of 3 or 4 days old; and this was all the observation I was able to make.

I come now, according to my promise, to speak of the nature of an eclipse of the moon, and of several observations and useful inferences, to be drawn from the eclipses of the luminaries.

Now an eclipse of the moon (as I have already shewn in my Diary for 1705) is caused by the earth's interposing or happening to be exactly in a right line between the sun and moon, by reason whereof the light of the moon is obscured by the shadow of the earth.

To conceive this aright, if you imagine (or actually put) a lamp or candle on one side of the room, (suppose five foot high from the floor;) and a looking-glass on the other side of the room, (five foot high also from the floor;) and if a fine thread was tied and stretched out streight (or if you imagined a right line extended) from the middle of the looking-glass to the flame of the lamp, overthwart the room; then if you stand in the middle of the room, half a yard (more or less) on either side the extended thread, (or imaginary line) and looking towards the glass, you may plainly see the light of the lamp reflected back to your eye, (or to speak as the common people conceive it, you may see the candle in the glass.)

glafs.) And the like will happen if you place your eye some distance either above or below the line.

But if you put your eye or head just between the lamp and the glafs, (where the line or thread is) then will your eye or head cast a shadow upon the glafs so that it cannot reflect back the light, (or to speak with the vulgar, it will stop the light so that it cannot shine on the glafs.) [And the same appearances would happen if the eye remained fixed to the string in the middle, and the candle was lifted up and down.]

Not much unlike this is an eclipse of the moon, for the moon hath no light of her own, but the sun shining on her, she reflects back his light, as the glafs reflects back the light of the candle or lamp; but when the earth happens to come just between, then it hinders the light of the sun from shining upon the moon, or to speak more properly, the shadow of the earth falls upon the moon and eclipseth her.

But to make this as plain as possible (and withal to account for the various phases of the moon, why she appears round, gibbous, half-round, horned, and sometimes not at all :) Suppose instead of a plain looking-glass you took a glass globe, and having it silvered withinside, to make it a globular looking-glass. Place this, instead of the other, opposite to the lamp or candle: suppose then in figure 1. the sun (*S*) represented the lamp, and the little circle (*e*) represented the globe looking-glass, and that your eye was placed somewhere between both, suppose at (*m*.) Now looking towards (*e*), (if the eye was either higher or lower, or on the one side or other of the imaginary line between them) then would the light fall upon (*e*) and reflect back upon (*m*) and half the globe would be enlightened. But if the eye be exactly in the middle between them, then would the eye shade the glass (as in fig. 2.) and so darken it. That is, it stops the light from shining on the glass, and so it cannot reflect any back. (Or as I said before, if the eye and glass remain fixed, and the light or lamp moved up and down, the same appearances would ensue.) And just after this manner, is an eclipse of the moon: the sun being on one side the earth (*S*) and the moon on the other (*e*): then if the earth doth not happen to be in the middle, as it for the most part falls out, (the reason whereof is shewn at large in the last year's Diary) then there is a full moon to us that live upon the earth, and no eclipse; but if the earth happen to be just between them, as many times it doth, then there must needs be an eclipse of the moon (as in fig. 2.)

From the consideration of what hath been here said, and viewing with some attention the first figure following, may the various phases or appearances of the moon be easily apprehended.

For

For the globe glass at (*e*) being round the light at (*S*) casts its beams, or shines upon that half opposite to it; for it must needs shine upon half, nor can it shine either upon more or less than half, but always upon that half that is just facing the light, the other half from the light being dark of consequence: I say the light (*S*) casting its beams upon (*e*) enlightens that half towards it, so to the eye that is in (*m*) directly backwards, the whole half is reflected back, and appears perfectly round in the edges.

But if you order an assistant to remove the lamp to (*f*), then part of the enlightened half to you at (*m*) is turned from you, and you can see but three parts of it, and one quarter of the dark'ned part becomes turned towards you. If the light is removed to (*g*) and then but one half, if to (*b*) but one quarter, and if to (*a*) then none at all of the enlightened half to you at (*m*) is to be seen, it being from you; and if it was removed still on to (*b, c, d, e*) the light would encrease to the eye placed at (*m*) as it did decrease before.

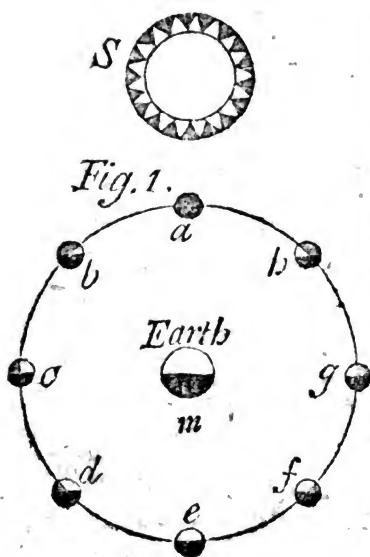


Fig. 1.



Fig. 2



This being rightly conceived, if instead of the imaginary lamp at (*S*) you conceive it to be the sun, and if for the globe-glass

glafs at (e) you conceive it to be the moon, and for the eye at (m) you conceive it to be the earth you stand on, the very fame appearances will happen, and consequently the reason of the various appearances of the moon are, I hope, made very plain without any farther explication.

But to return from this digression to the eclipse. If the earth's shadow covers the moon but in part (more or less) it is called a partile Eclipse, but if it cover it in the whole, it is called a total Eclipse.

Such an Eclipse will happen on the sixth day of April next, the beginning will be a little before midnight, and will continue till half an hour after three next morning, as followeth.

April the 6th, 1707.

	ho.	min.	
The beginning of the eclipse will be at	11	40	} at night.
Beginning of total darknes	—	12 45	
The middle of the eclipse	—	1 34	} next morning.
End of total darknes	—	2 24	
End of the eclipse	—	3 29	
Total duration will be	—	3 49	} And thus much of this eclipse.
Total darknes will continue	—	1 39	

Observations on Eclipses of both luminaries.

1. The sun is very seldom, but the moon often totally eclipsed, yet in the whole, the eclipses of the sun are the more frequent of the two.

2. The beginning and end, and quantity eclipsed, of an eclipse of the moon, is seen from all parts of the earth (where it is conspicuous) at the same moment of time (altho' under diverse meridians:) but in eclipses of the sun it is not so, being at the same moment of time seen less in one place than another, and lasting in some places shorter, in others longer, and in some none at all.

3. The beginning of an eclipse of the sun is on the western part of his limb, which part is also first restored to light. But in an eclipse of the moon, it begins and ends on the eastern limb.

4. Total eclipses of the moon are made sometimes in a longer time, at other times quickly: but total eclipses of the sun are all without delay.

5. The moon in total eclipses is sometimes quite lost, but at other times it shines very plainly with a red colour, either in whole or in part.

The uses of, or conclusions drawn from, Eclipses.

1. The course of the moon would not truly be known without eclipses, by reason of her parallax.

C

2. The

2. The sun is both higher and greater than the moon.
3. The earth is greater than the moon, but less than the sun.
4. Both sun and moon are spherical, unequally distant from the earth.
5. The sun is the fountain of all light, but the moon is but a borrowed light from the sun.
6. From eclipses are found the difference of meridians or longitude of places.
7. From eclipses of the sun and moon, a reason is found of measuring their distances from the earth, as also of the magnitude and proportion that the sun, moon, and earth have between themselves; which otherwise may seem impossible.

By these wings it is the mind of man flies up into the heavenly theatre, and by these charms (as the poet saith) draws down the sun and moon from heaven to earth.

1708.

Of the Ptolemaick System of the Universe.

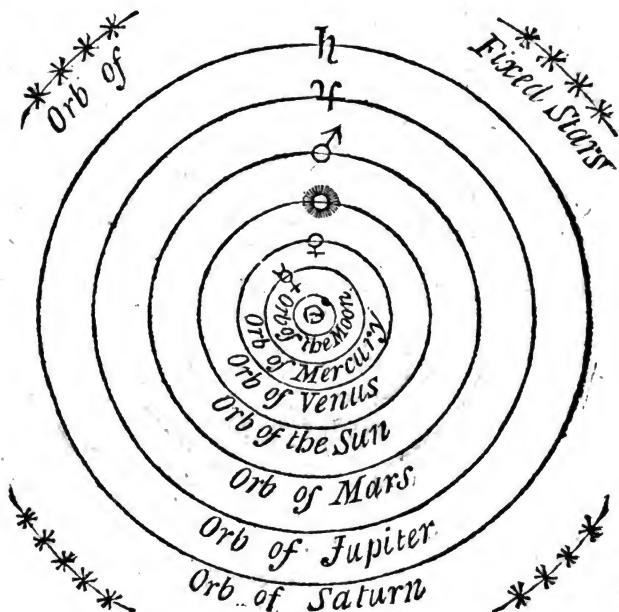
HAVING in my former Diaries explained the motions of the sun and moon, as also the nature of their eclipses, with the reason why the moon appears in so many various shapes in the space of one revolution; I come now to speak of the other five planets, viz. Saturn, Jupiter, Mars, Venus, and Mercury: but before I proceed it will not be amiss to explain the system of the universe.

There are various opinions among the learned concerning this difficulty, but the most prevailing are these two, namely, the Ptolemaick, and the Copernican, both which I shall now explain.

Ptolemy, Aristotle, and others held, that the earth is the center of the universe, which remains fixed and immoveable, and the whole heavens, and fixed stars, move round her in this order. (See fig. 1. following)

The planet that moves in a circle or orbit, next above the earth, is the moon; next above her moves the planet Mercury; next above Mercury, at a greater distance still from the earth, doth the planet Venus move; and still in a higher orb moves the glorious sun; the planet next above the sun is Mars; and Jupiter moves still in an orb or circle, extended every where beyond the orb of Mars: Lastly, the farthest of all the planets from the earth is Saturn, and he moves in a larger

larger circle than them all. Above these planets, a vast distance, are the fixed stars, and above the fixed stars, is the primum mobile and emperial heaven. And this is the Ptolemaick hypothesis.

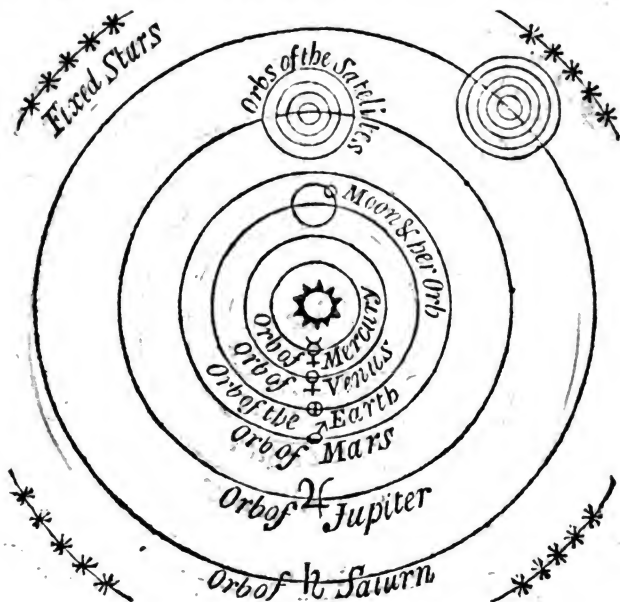


Of the Copernican System of the Universe.

THE Copernican system makes the sun to be the center of the universe, (as in the following fig.) round which (in the order there seen) are the orbits of Mercury, then that of Venus, then that of the earth, with that of the moon about it; then those of Mars, Jupiter, and Saturn, one above another, and about the two last the small circles, that their attendants or satellites march in, of which more anon; and above all these the fixed stars, &c.

This is the order of the heavens, according to Plato, Aristarchus, Archimedes, and other ancients; and after it had been almost quite forgot for many ages it was revived by Copernicus, and is now almost universally received.

However, both these hypotheses do equally solve the doctrine of the sphere, the first being the most easy for beginners, but the latter the more rational.



But since these hypotheses have been received in the world, the later astronomers have, by the help of the telescope, found out many surprizing appearances, which I shall set down more particularly in the order as they lie in the heavens, beginning with the uppermost, and so descending down to our earth.

And first for the fixed stars: that whitish band or zone, that encompasses the whole heavens, called the Milky-way, and of which the ancients could give no tolerable account, is found by the telescope to be no other than an heap of very small stars, thickly set together; which by their great distance, smallness, and closeness, appear to the naked eye, as one united whitish cloud. In like manner the Pleiades, or Seven Stars, tho' (saith my author Mr. Molyneux) scarce more than six appear, are found by an ordinary glass, to be nigh forty; and Dr Hooke, in his Micrographia, saith, that with a twelve-foot telescope he plainly discovered 78 in the same asterism, of no less than 14 several magnitudes, the biggest whereof

whereof is not accounted greater than one of the third magnitude. And in the single constellation of Orion, the telescope discovers more stars, than the naked eye can number, in all the heavens; and there is scarce any corner of the heavens so dark but the telescope being turned towards it, descries multitudes of glittering spangles therein. On this account the seed of Abraham, that was to be made numerous as the stars in the firmament, may yet (for ought we know) admit of propagation thro' many future generations, before it comes up to its limits.

From the fixed stars let us contract our prospect, and in a vast, long, and almost immense course homewards, we first meet with Saturn. By his slow motion he takes state upon him (being near 30 years in walking round the heavens) as carrying about him something more weighty than ordinary. But the short sight perceives nothing thereof, and sees nothing but a plain round globe, all his equipage and attendants are hid from our view, till survey'd more closely with the telescope, and then behold a mighty ring, parallel to the equator, bright as the planet's own face, encompassing round his body: but this is not all his equipage, for besides this throue of light, this majestick planet is constantly attended by a guard of five satellites or moons, that follow his motion, and dance round him continually in a circle.

Jupiter next presents himself, less encumbered than Saturn; yet not wanting a courtly train; for, tho' his guards are but four in number, yet their size and brightness shew their strength, and their quick motion round him shews their diligence.

Galileo (who invented the telescope) was certainly the first inhabitant of this globe that ever saw them, and how strangely was he surprized, and struck with wonder, to see four little moons dancing round Jupiter, that from their first creation, to that lucky moment, had never struck the eye of any mortal inhabitant of this globe before. Were these then made for the use of poor man, from whose knowledge these were concealed for 3000 years together? Vain man! that thus presumest to confine the designs of the Almighty to miserable dust and ashes, when his infinite power can make millions of intelligent beings, to serve and praise him.

Besides these four little moons about Jupiter, the telescope discovers that there are about his body several brighter and darker parts like broad belts or zones, almost parallel to the ecliptic; as also a spot found in him, by which 'tis manifest that Jupiter turns round his own axis in the space of about 10 hours. A very strong argument to prove that our earth may do so likewise, since Jupiter who is so considerably bigger than the earth, has a motion much more quick than ours in 24 hours. He moves about the heavens in about 12 years.

Mars offers himself next, who trusting in his own strength is attended by no guards; he compleats his circle in 687 days; but the prying telescope discovers in his face, scars, spots, and ruggedness, by which the ingenious Cassini has determin'd, that he turns on his own axis, once in about 24 hours and three quarters. But however furious his beams are, he is beholden for them to the great fountain of light, and heat, the sun, which is plainly visible, in that, when he is in his quadratures with the sun, and in his perigæon, he may be seen almost bisected, and to increase and decrease in light as our moon (but never so much as to be horned as the other inferiors.)

The glorious Sun doth next present itself, in whose bright face we can hardly expect to find dark spots; yet such there are, and frequent too.

Scheinerus has publish'd a large book in folio, of nothing else: the only discovery that has been made by these spots, is, that the sun turns round about his own axis in the space of 25 days and a quarter. Formerly one should seldom see the sun's face (no more than now our brighter beauties here below) free from one or more black patches, but now (as if they were grown out of fashion) he seldom wears any, one in five or seven years hardly appearing; as if now he put them on, more of necessity to cover an odd pimple, that may otherwise disfigure his countenance, than to adorn his face: how far the fair sex should follow his example, I dare not venture to determine; but from them we naturally fall to Venus.

Venus, the brightest planet in the heavens, she fears not sometimes, even at noon-day, to display her beauty, and in this armour reposing an entire confidence, performs her course alone, and free from all other attendants, in 225 days.

Mercury's wit and quickness secures him; therefore he has no train, but generally shelters himself under the beams of his potent lord, the sun, and performs his circuit round him in about 88 days. But both these inferior planets are found by the telescope to increase and decrease as our moon; for sometimes they appear horned, sometimes half enlighten'd, sometimes gibbous, and sometimes full, even on, or nigh this conjunction with the sun: by which it is manifest, the Ptolemaick hypothesis is false, whatever hypothesis is true.

And thus at last are we arrived at home to contemplate our neighbour the Moon, which we may call our own; for as the satellites about Saturn and Jupiter move about them, so moves the moon as a satellite about us. By the telescope we distinguish in the moon's countenance, an admirable difference of parts, both for shape and colour; the greater parts resembling our seas, lakes, rivers, islands, peninsulas, and continents; the lesser spots resembling mountains, hills, and valleys; but whether the moon is inhabited or not still admits

mits of various disputes, tho' believed by the most ingenious so to be:

1709

Of the Nature and Motion of Comets.

COMETS, or blazing stars, were by the ancients taken to be nothing else but vapours and exhalations, or such-like dissipable matter: But by our late astronomers (and that more truly) they are found to be a species of planets, that revolve about the sun in elliptical orbits, whose periodical times and motions, are as constant, certain, and regular, as those of the planets. The elliptical orbits are so very oblong and excentrical, that they are but little different from parabola's, and may be considered as such.

Also the inclination of the plains of the planets, are at most not above five or six degrees different from the plain of the ecliptick, yet the plains of comets are exceeding various, and are at all imaginable angles of inclination with one another, and with that of the ecliptick.

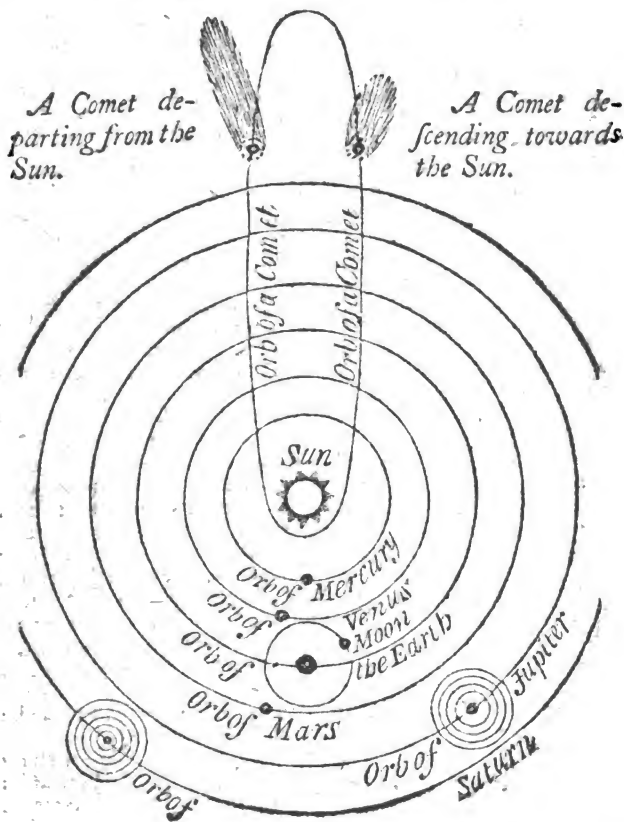
Likewise the course of comets in the orbits is not determined one way, (as is that of the planets from west to east) but indifferently; some of them move one way and some another: for sometimes they move from east to west; sometimes from west to east; sometimes from north to south; other times from south to north; and sometimes obliquely between any of these ways, according as the situation of the plains of their orbits, and the direction of their courses together do determine.

It is observed, that comets in their descent to, and ascent from the sun, pass quite through the planetary system, as by the ensuing figure may plainly appear; which effectually confutes the notion of solid orbs, which some of the ancients so fondly conceived.

Some comets approach in their perihelia, so very near the sun, that they must be prodigiously heated thereby, and this to such a degree, that they may not be intirely cold for many years. Thus the last famous comet in 1680 and 1681, at its perihelion on the eighth day of December 1680, sustained a degree of heat twenty eight thousand times as great as that we feel with us in summer; or about two thousand times as intense as is that of a red hot iron. So that by Sir Isaac Newton's calculation, if that comet was as big as our earth, as dense

dense and solid as iron, and were throughout equally heated to the forementioned degree, 'twould scarce, in our air, be fully cooled in fifty thousand years: so that it cannot consist of vapours and exhalations as the ancients thought.

The solar system, with the manner of a comet's departure from, and descending towards the Sun.



The ingenious Captain Hally saith, that the comet which appeared in 1682, will probably appear again, in 1758, being 50 years yet to come. But by a careful review of the history of comets, I have, with no small pains, endeavoured to find out the times of the revolutions of several of them: and if the histories I have perused are true, there will be several appearances of them, before that time; nay, I am almost persuaded

That one (or more) comet or blazing star, is now near at hand, or some strange appearance in the heavens.*

1710

Of the Fixed Stars.

HAVING in my former Diaries, given an account of the sun, moon, and other planets; of the various systems of the heavens, of the wonderful discoveries made by the telescope, of the systems of the comets, and of the passions and affections of the wandering stars, I come now to treat of the fixed stars, and of their various magnitudes, distances, number, and constellations.

All those glittering stars (except seven) which we see bespangling the firmament of heaven, and encircling the terrestrial orb at unmeasurable distances, are called fixed stars; for tho' they seem to roll about the earth in four and twenty hours, yet they keep the same distances from one another, and from the ecliptick, they rise and set upon the same points of the horizon, and pass the meridian at the same altitude, and are as if they were so many lucid points fixed to the celestial

* The above discourse and prediction of our author seems to have had very sufficient grounds for a foundation; for, when he had perceived from *Doctor Hally's Astronomia Cometica Synopsis*, or otherwise, that at least fourteen comets had been observed in different years throughout the preceding century, he needed no witchcraft to assert that *several* would appear during the next 50 years; and accordingly many comets appeared during that time (as we shall remark in their respective years as they occur in course), and among the rest Doctor Hally's answered very well according to his prediction. Our author however does not seem to have had the pleasure of observing the accomplishment of his prediction, as he died in 1713 or 1714, and I find no accounts of any more comets before the year 1717.

lestial firmament, for which reason they are called the fixed stars.

The number of them which appear to the naked eye, according to the ancient astronomers, are 1022. But since the telescope hath been invented, they are found to be innumerable.

Their distances from us are incredible, being according to the computation of our modern astronomers, so far off, that if from one of the biggest stars, (which are supposed to be the nearest) a bullet was shot out of a cannon, and to continue its utmost swiftness till it arrived at our earth, it would be little less than seven hundred thousand years in its journey, before it could reach us.

Their magnitudes are no less amazing, for according to Gallileus (whose account is much less than some others) the body of the least star is above nine hundred thousand millions of times bigger than the globe of the earth.

But to wave at present these nice speculations, and to come to particulars more obvious and certain: Let us suppose ourselves in an open plain, in a curious clear and charming night, viewing the bespangled heavens, and beholding the wondrous works of the Almighty; we cannot but observe stars of different bigness, and of different lustre and glory. To distinguish these from one another, the ancients divided them into six degrees of bigness or magnitude: those that you see the biggest and brightest of the whole firmament, they called stars of the first magnitude; those that you see of the next inferior bigness and brightness, they called stars of the second magnitude; those of the next degree, stars of the third magnitude; and so they gradually decreased to the sixth magnitude, which are the smallest stars of all: now to many of the most eminent stars, the ancients gave particular names, calling one Aldebaran, another Regulus, a third Rigel, a fourth Arcturus, a fifth Procyon, a sixth Dubbe, and so of many others of divers magnitudes, giving names to about fifty stars in all.

To have devised names thus for every star, would have been very troublesome, if not impossible; to remedy this inconvenience therefore, they separated the stars into divers parcels, some more and some less; and formed them by their imagination, into the shapes of men, women, birds, beasts, and the like; which served them to as good purpose, as if the appearance of those shapes were visible in the heavens; for by these images or imaginary creatures, they came to know and name the stars, as distinctly, as if they were called by particular names; and after they came to be more accurate in astronomical observations, they put down upon paper, the true bearing, distance, and magnitude of the stars, and actually drew about them the shapes as they before imagin'd them

them in the heavens: and thus they parcelled out all the visible stars into * 48 constellations or parcels, 12 whereof were in the middle of the heavens, encompassing it about like a girdle, which they called the 12 signs, (in which the 7 planets always move) 21 constellations or images they parcelled out towards the north part of the heavens, and 15 towards the south, to which the modern astronomers have added 12 more in the southern hemisphere, unseen by us.

But that my fair reader may the better apprehend my meaning, I shall descend to some particulars. Not far from the north pole, the ancients parcelled out 35 stars, whereof 7 are of the second magnitude, 3 of the third, 8 of the fourth, 12 of the fifth, and 5 of the sixth magnitude, and formed about them the shape of a bear, and called this constellation by the name of the Great Bear, (to distinguish it from another constellation of 10 stars, lying near these, called the Little Bear) which being put down upon paper, in their true and proportionate distances and magnitudes, as they are in the heavens, with the image drawn about it, will appear as in the figure *marked on the celestial globe*.

From which figure the stars in the heavens may be easily known, and distinguished, the one from the other.

Thus there is the star at the end of the tail of the great bear, the star in the middle of its tail, and the star in his rump, which has a distinct name given it, viz. Alioth, (as also hath that star in his back called Dubbe); the lower star in his hinder foot, and the star in his mouth or under jaw; and so of the rest, according to the places or parts of his body wherein they are posited.

But these seven more eminent stars (all of the second magnitude) are by seamen separated from the rest, and made a constellation by themselves, called the Wain or Charles's Wain, whereof the two lower stars are the two wheels, the two stars above these are the waggon part, and the other three stars the three horses (or oxen) to draw it; whereof one is the thill-horse (or the filler) called Alioth, the middle-horse, and the

* The number of constellations now in use are 77, viz. the 12 signs or constellations of the zodiac, 28 constellations on the north of it, and 37 on the south. Many stragling or unformed stars having been reduced into constellations by modern astronomers.

The number of stars also now put upon the constellations are more in number than those mentioned by our author in this discourse, as I shall shew at the end of it.

In perusing the descriptions of these constellations, the reader ought to have at hand a celestial globe; and comparing each constellation and star there with its description here, will impress a very just idea of its form, situation, &c.

the fore-horse of the wain. The image, picture, or shape of this wain, you may easily form in your own imagination.

The farthest two stars from the end of the tail of the great bear are by our seamen called the guards; for by them they find the star at the end of the tail of the little bear, called the pole star: Thus, if you look upon these two stars in the heavens, and extend a line in your imagination from the one to the other, and so continue it in the heavens about five times the distance of those two stars, you will meet with the pole star of the second magnitude; or the end of the tail of the little bear (of mighty import to the seamen) or by some called the fore-horse of the little wain, from whence you will easily find the 7 stars of the little wain, being in the same shape as the greater wain. [But the ancients added 3 stars more to these 7, and formed the constellation into the shape of a little bear, as I said before.

A little behind the tail of the great bear, are another parcel of stars, which the ancients drew into the image of a man, and called this constellation Bootes, or the driver of Charles's wain. He is also called Arctophylax, the keeper of the bear. There is another star in the border of his garment, of the first magnitude, several times mentioned (with other stars and constellations) in the holy scriptures, namely, Job. 9. 9. Job 38. 32. and in Amos 5. 8. It is called Arcturus, which in the hebrew signifies a congregation or gathering together, suitable to the expression in Job 38. 32. Canst thou guide Arcturus with his sons? that is, with all the other stars that make up that constellation.

Any of the stars of this constellation may be known as in the last; for I should say, the star between his hook and his head; that in his cheek; that in his girdle; the lowermost in his leg; the middlemost in his knee; the uppermost between Arcturus and that in his knee, &c. you can easily point them out, and know them as distinctly as if each of them had a particular name.

Another company of stars that encompass the pole of the ecliptick, and lie dispersed in various places, the ancients formed into an image or constellation called the Dragon, wreathing and twisting itself betwixt the two bears: It is a notable constellation, having stars in every one of the 12 signs, and the pole of the ecliptick is in the very middle of it. It hath one star of the second magnitude, being the last but two in the tail. Another star is called Rafaben, being a bright star in the head of the dragon, famous for that the ingenious Mr Robert Hooke, Fellow of the Royal Society, made use of this star, to attempt the proof of the motion of the earth by observation, in 1674. Where he observed (as the Reverend Mr Flamsteed hath diverse times since) a parallax of
the

the earth's annual orb, which infallibly proves the motion of the earth to be true, according to the doctrine of Copernicus.* To give one instance more:

Behind the neck of the dragon, the ancients formed another constellation of stars into the image of a swan. The star near the tail is of the second magnitude, and is called aridef or arided; and near the star in its breast a new star appeared in the year 1601, and after some time disappeared. In the year 1658 it appeared again, and likewise in the year 1670, and so it continued appearing and disappearing several times; it was a star of the third magnitude, and at this time wholly disappears.

The stars in this (as in the other constellations) are easily known and distinguished, if you observe about what parts of the head, neck, breast, wings, tail, &c. they are placed. What their magnitudes are, &c.

And thus you see the method made use of by the ancients, to distinguish and name the greatest part of the visible stars in the firmament, by forming most of them into images and constellations.

There are some few of the lesser stars, which could not conveniently be brought into constellations, which they called informes, or unformed stars, such as the six small stars beneath the great bear; and the three stars before its head, the two small stars by the tail of the dragon, and divers others: yet these are also easily known by their situation, distance from, or neighbourhood to the constellations near which they are placed, or to some parts of them.

I am persuaded that nothing can be more diverting to the fair sex, than to be able to know and name the constellations and stars in the firmament, and to point them out to her fair companions in a serene clear night; saying, (for instance) "Look yonder, madam, that great star of the first magnitude, "is called the bull's eye, that cluster of little stars near it is "in the bull's neck, and called the pleiades; that star of the "second magnitude, is the end of his north horn; and that "of the third magnitude is the tip of his south horn. Look "yonder is the great warrior Orion. This constellation is
" men-

* Unfortunately for our author, and the great astronomers whose authorities he quotes, the change of place of the fixed stars hath been discovered since by *Doflor Bradley*, to be owing to other causes, viz. the aberration of the rays of light and the libration of the earth's axis. The parallax of the earth's orbit not amounting to one second, and is quite imperceptible to all instruments.

But this mistake does not however invalidate the *Copernican* motion of the earth, that being sufficiently proved by other means.

"mentioned, with the pleiades and others, in the book of Job, cap. 38. Those three stars of the second magnitude, is called his girdle; and that star of the first magnitude, on this side it, is in his left shoulder; and that great star of the first magnitude, beyond his girdle, is in his right foot, and is called rigel; those three small stars in a right line, are in his sword. Look yonder, farther southward, in a streight line with Orion's girdle, is the most glittering star in the heavens, called sirius; this star, with 18 others, make up a constellation called the great dog; this sirius being in his mouth, and that other towards the right hand is in his left foot, &c." The knowledge of these particulars, I presume, will be very entertaining to the ladies, all which I shall endeavour to shew in some of the succeeding Diaries.

1711

Of the Constellations of the Zodiack.

IN my last year's diary, I began my discourse of the fixed stars; and therein shewed you, how the ancients (the better to know them) separated them into divers parcels, called constellations; giving to some of them the names of men and women, as Cepheus, Orion, Cassiopea, &c. to others the names of beasts, birds, fishes, &c. as the lion, the bull, the eagle, the whale, &c. to others the names of inanimate beings; as the altar, the ship, the balance, &c. And the better to give my fair reader a just notion or idea of these constellations, I there shewed you, that there were 48 of these images or constellations reckoned among the ancients; namely, 12 in the middle of the heavens, 21 on the north side, and 15 on the south side the same; all which I designed only as an introduction to the knowledge of the fixed stars. I shall now proceed to instruct my reader, not only in the knowledge of the names and shapes of the constellations, but also how to find them in the heavens, and to point out the most noted stars in the firmament.

I shall begin with the 12 images, that environ the whole heavens in the middle like a girdle or zone; for which reason they are called the 12 signs of the zodiack; and because they are so often mentioned, and come frequently into use (more especially because the seven planets, or wandering stars, constantly move therein.) The ancients invented 12 characters

or

or marks to represent them; not made at all adventures, but neatly contrived to know them thereby, and which are made use of at this day.


These 12 images, constellations, or signs, are placed in the heavens in this order: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces, and are placed in the heaven from west towards the east, or (with us) from the right hand towards the left.


Thus, if I see Aries in the heavens, the next sign Taurus, stands towards the left hand, or easterly of Aries, and the next sign Gemini, stands more easterly, or on the left hand (to us) of Taurus, and so of all the rest.


The first constellation, or sign in the zodiack, is called Aries, or the Ram; and the character or mark the ancients made use of to know it, was two horns set upright, thus, ♈. This sign consists of nineteen small stars, whereof that called the first star of Aries is the most remarkable, because from it many astronomical tables were formerly calculated; and from this star Copernicus accompted the procession of the equinoctial. About four hundred and seventy years before our Saviour's time, this star was in the first scruple of Aries; but it is now in 29 degrees and 4 minutes of the same sign; and about 1780 it will entirely leave Aries, and be got into the sign Taurus. There is also the bright star on the top of his head, the star in the rump, &c. as I shewed you more fully in my last. (Over the ram is a small constellation of three stars called the triangle, which I have here also remarked the better to find out Aries by.)


The next constellation of the zodiack is Taurus, the Bull, denoted by the ancients with a horned head of a bull, thus ♉. This image consists of 48 stars, whereof one is of the first magnitude, called his south eye; it is also called by the Arabians, aldebaran. Another in the tip of his north horn is of the second magnitude, that of the third magnitude is the star at the end of his south horn, then the star in the bend of his knee, &c. In this greater constellation, are included two smaller, one of five stars in his forehead, in form of the roman V called the Hyades, (whereof aldebaran is one of the top of the V). The other is a cluster of stars in his neck, (commonly called the seven stars, and known to every boy in the streets: called in the scripture (Job 9. 9.) the Pleiades. The other stars in this constellation are easily known, by the places they possess in the image, whether it be in his horns, legs, face, neck, &c. as I fully shewed you in the last year's Diary.


The third constellation in the zodiack is Gemini or the Twins; and is characterized by two boys embracing one another, thus, ♊.


The fourth sign, is Cancer or the Crab, and is known by a character of two opposite eyes and horns, thus, : This constellation hath none but small stars only, two of them are of the third magnitude, that in the breast is called præsepe, much celebrated by the ancient poets; as are also the other two called the north and south asselli.


* The fifth sign in the zodiack is Leo or the Lion, which the ancients agreed to be designed or characterized by a lion's tail turned upright thus , containing 43 stars, whereof 2 are of the first magnitude, viz. the lion's heart, called Regulus; and the lion's tail, called Cauda Leonis, and is a very fair star. There are also in this image 2 stars of the second magnitude; namely, one on the top of his loins, and the other in his neck; by which 4 stars all the rest may be easily known.


The sixth sign is Virgo, or the Maid or Virgin, which is denoted by the folds or hems of a woman's garment in this manner ; of above 40 stars, and hath one considerable one of the first magnitude, called Spico Virginis, or vindemiator.

The seventh sign in this circle is called Libra, or the balance or pair of scales, which they have portraicted in the similitude of a ballance in this manner,  consisting of 14 stars, whereof 2 are of the second magnitude, viz. one in the southern-scale, called lanx meridionalis, and the other is sometimes called bilanx.

† The eighth sign is Scorpio, or the Scorpion, described by the knotted tail and sting of a serpent thus,  which hath one of the first magnitude, called Cor Scorpionis, or the Scorpion's Heart, and one of the second magnitude in the head.

The ninth sign is Sagittarius, or the Archer, which the ancients have noted with the portraicture of an arrow thus, ; called also the Centaur; it consists of 30 stars, two whereof are of the second magnitude, one in the knee of his right leg, and the other in the heel of the same leg. Between his two forefeet is placed another small constellation called the Southern crown, (corona austrina.)

The tenth sign is Capricorn, or the Goat, which antiquity noted with a goat's foot tied in a string thus, ; consisting of twenty eight stars, but none of them either of the first or second magnitude.

The eleventh sign is Aquarius, or the Water-bearer; which the ancient astronomers have depicted by the waving of water thus ; having 42 stars in it, but none of any considerable magnitude.

The twelfth or last sign of the zodiack is Pisces, or the Fishes, and this image is represented by two fishes bound together

* From the diary for 1712.

† For 1713.

gether thus, ♄; which contains 36 stars, but none of them either of the first or second magnitude*.

† As the ancients did nearly characterize the 12 signs, so likewise did they depict the 7 planets in like manner, which I shall now also shew you.

Saturn is depicted like an old man leaning upon a Staff, after this manner ♄.

Jupiter

* Our author dying before he had completed the descriptions of all the constellations, as he had promised and intended, I shall here supply the defect by subjoining the whole catalogue of constellations and number of stars upon each, as now generally used.

I. The twelve constellations in the zodiack, with their characters and number of stars, are thus:

Stars				Stars.			
1 Aries	♈	—	20	7 Libra	♎	—	20
2 Taurus	♉	—	53	8 Scorpio	♏	—	25
3 Gemini	♊	—	33	9 Sagitary	♐	—	22
4 Cancer	♋	—	31	10 Capricorn	♑	—	30
5 Leo	♌	—	45	11 Aquarius	♒	—	49
6 Virgo	♍	—	50	12 Pisces	♓	—	39
Sum 232				185			
				232			

The stars in the zodiack are 417

II. The 28 northern constellations are

Stars				Stars.			
1 Urfa minor	—	—	19	15 Perseus	—	—	40
2 Urfa major	—	—	39	16 Auriga	—	—	27
3 Draco	—	—	37	17 Serpentarius	—	—	31
4 Cepheus	—	—	34	18 Serpens	—	—	18
5 Camelopardalus	—	—	28	19 Sagitta	—	—	8
6 Jordanus	—	—	31	20 Aquila	—	—	24
7 Bootes	—	—	38	21 Antinous	—	—	12
8 Corona Borealis	—	—	9	22 Delphinus	—	—	11
9 Hercules	—	—	34	23 Equiculus	—	—	4
10 Lyra	—	—	17	24 Pegasus	—	—	25
11 Tygris	—	—	38	25 Andromeda	—	—	34
12 Cygnus	—	—	29	26 Triangulum	—	—	5
13 Sceptum	—	—	17	27 Irinus	—	—	7
14 Cassiopeia	—	—	30	28 Coma Berenices	—	—	13
400				259			
				400			

Northern Stars 659

† From the diary for 1711.

III. The

Jupiter is represented like a king bearing a scepter thus ♃.

Mars is noted by a war-like engine, thus ♂.

The Sun by a round figure, thus ☉: and sometimes by a figure beamed about after this manner ☼.

Venus is figured in the shape of a young maid, thus ♀.

For Mercury they drew a young man with wings in his cap, after this fashion ☿.

And lastly, for the Moon, they marked, it horned, thus ☾ or thus ☾, as she appears in her quarters.

The author, at the bottoms of the almanack pages for 1710, thus describes the constellations, in verse.

The northern constellations.

Within the glorious firmament, the sky,
Doth eight and forty constellations lie.

First

III. The 37 southern constellations are

Stars				Stars			
1	Cetus	—	28	20	Phoenix	—	13
2	Orion	—	60	21	Indus	—	12
3	Eridanus	—	36	22	Pavo	—	14
4	Lepus	—	13	23	Apus	—	11
5	Canis major	—	19	24	Musca	—	4
6	Columba	—	11	25	Cameleon	—	10
7	Canicula	—	11	26	Tringulum australe	—	5
8	Monoceros	—	23	27	Piscis volans	—	7
9	Navis	—	46	28	Dorado	—	4
10	Hydra	—	29	29	Nubes	—	3
11	Crater	—	11	30	Toucan	—	8
12	Corvus	—	9	31	Hydrus	—	10
13	Crux	—	4	32	Nubecula	—	3
14	Centaurus	—	35	33	Rhomboides	—	4
15	Lupus	—	21	34	Royal Oak	—	10
16	Ara	—	7	35	Lynx	—	19
17	Corona australis	—	13	36	Vertagus	—	23
18	Piscis australis	—	17	37	Unicorn	—	19
19	Grus	—	13				

First near unto the cold and northern pole,
 The dragon lurks, and both the bears do rowl.
 (The hinder parts of each, sev'n stars contain,
 Called the lesser, and the greater-wain,
 The hare comes next, the bear-ward, and the crown,
 Then hercules advances kneeling down:
 Great serpentarius riding on his snake,
 Doth next a formidable image make.
 Under the tuneful harp of Orpheus
 Are plac'd the Eagle, and Antinous.
 The silver Swan her downy wings do spread
 Above the dart, and sportive Dolphin's head.
 Then Pegasus comes flying on amain,
 Andromeda next follows in her chain:
 (The Triangle at a small distance stands,
 And at her feet you see in Perseus's hands,
 The monstrous Gorgon's head; above are seen
 Cepheus, with Cassiope his queen.
 Auriga with his goat and kids appear
 At last, which ends the northern hemisphere.

The twelve signs, or constellations of the Zodiack.

Between the north and south, all round the sky,
 Just in the midst, twelve constellations lie
 We call the signs; and first the Ram begins,
 The Bull next follows, then the loving Twins.
 The Sea-Crab, Lion, and the Virgin tender;
 Then comes the Balance, Scorpion, and Bow-bender;
 The bearded Goat, next follows in the train,
 The Waterman comes next, then Fishes twain,
 Do bring you round unto the Ram again.

The southern constellations.

Within the space o'th' southern hemisphere,
 No more than fifteen images appear;
 The monstrous Whale claims place before the rest,
 Eridanus's streams flow near his breast.
 The Hare is next, and then Orion bright,
 Who shines most glorious in a winter's night.
 Then comes the great dog Sirius, at whose tail
 The famous Argo spreads her yielding sail;
 Above her masts the little dog doth flame:
 (This constellation hath no latin name.)
 Next Hydra stretcheth out her tail afar;
 The Crow and Pitcher, near it seated are:
 The monstrous Centaure holds the Wolf by th' heel;
 Then comes the Altar and Ixion's wheel.
 The southern fish at last brings up the rear,
 And thus you have the southern hemisphere.

About

About the southern pole, far distant be
 Twelve constellations, which we cannot see;
 They're call'd the Crow, the arabian Phoenix, and
 The Indian man, with three darts in his hand.
 The bird of paradise, the little fly;
 The fine tail'd Peacock, the Camelion fly;
 The south Triangle, and the southern Snake;
 The Toucon Goose with its long monstrous Beak;
 The fish Dorado, and the flying Fish;
 Two magellanick clouds likewise there is.

1713

Of the reasons why the antients brought the stars into these figures and representations, according to Dr. Hook, and some others.

AND first the stars, if not precisely, yet after a sort, do represent such a figure as they have depicted it by: thus the three stars over the head of the ram, that is in the shape of a triangle in the heavens, they have drawn upon the globes and maps of the fixed stars, the figure of a triangle: and the seven stars in the tale and back, both of the great and little bear, is called the greater and lesser wain or waggon; because it pretty well resembles it, and so doth the crown and scorpion as some people imagine.

A second reason was, to continue the memory of some notable men, who either in regard of some mighty and signal atchievement done, or in regard of their singular pains taken in advancing astronomy, had deserved well of mankind; such as Hercules, Perseus, and others.

A third reason was (according to the superstition of the antients) that these images express some properties of the stars that compose them; as those of the ram, to be hot and dry; Andromeda chain'd, betokeneth imprisonment: the head of Medusa cut off, signifieth the loss of that part: Orion with his terrible and threatening gesture, importeth tempests and dreadful effects: the Serpent, the Dragon, and the Scorpion, signifie poison: the Bull insinuateth a melancholy passion: the Bear inferreth cruelty, and the like.

And lastly, besides all this, the poets had this design touching the reason of the invention of these constellations, namely, to make men fall in love with astronomy; they saw that astronomy being of singular advantage to the life
 of

of man, was almost utterly neglected; hereupon, they began to set forth, that under fictitious and delightful stories, that thereby such as could not be persuaded by advantage, might by the pleasure be induced to take a view of these matters, and thereby at length fall in love with them. Some of these poetical stories you may have hereafter.

1711

How to know the fixed Stars.

But cries the fair-inquisitive, by what means or ways must I know these stars in the heavens?

I answer. There are divers ways or helps to know them; some of which I shall here put down.

1. The first way then to know the stars, is, by having the picture or representation of the constellations by you, and knowing one or more stars in the heavens of the same constellation, by comparing the stars in the picture or figure, and those in the heavens; and considering their situation, distances, and magnitudes in the one, you may easily find out those in the other.

Thus for example, I would know the stars in the heavens of the constellation Taurus: I take the picture in my hand, and go out in some fair Night, and viewing the heavens, I find out the little cluster of stars called the seven stars, (known almost by every body.) Then I look upon my picture, and observe, (holding the backside of it towards that part of the heavens, and the picture of the constellation towards me.) I say I observe in the picture thus held, a large bright star bigger than all the neighbouring stars, that is further from me, (or nearer to the earth) and more towards the east or left hand, called Aldebaran: then I look up into the firmament, and there observing the same position, and bigness of the stars, I soon find out Aldebran; or the Bull's south eye.

Having found out this star, I look again on it, and in the figure of this constellation, I find five stars placed * * as in the margin, like a figure of five, or the Roman V. * * One of the 5 stars on the top of the roman V, being Aldebaran, which I just now found out; and that these five stars make up a small constellation, called the Hyades, I look then in the heavens, and considering Aldebaran as one of the tops of this V. I soon find out the Hyades, and that the other star is the northern eye of Taurus. Now I would find out the two horns of the bull (or rather the two stars at the tips of his horns. To do which, I view my constellation or picture, and observe, if I imagine a line from the single star at the bottom of the V or Hyades, I last found out, to be extended straight forwards on one side, and on the other side the V, each

line will go a little without side the north-horn, and the south-horn, both being towards the east or left hand of the V. Otherwise I may do thus; I find in it, that the Pleiades, (or 7 stars) and the Bull's eye (or Aldebaran) and the Bull's north-horn make a triangle; the sides from the Pleiades and from Aldebaran being pretty near equal, and something farther in distance, than it is from the Pleiades to Aldebaran; I look then in the heavens, and soon find the north star out. and by that the south horn is easily found, being nearer towards the earth and about half the distance, as it is between the Pleiades and Aldebaran.

Or I might consider the Pleiades and Aldebaran, and the north and south-horns as a Trapeza, or 4 sided figure, and that the two nearest stars, (or shortest side) is towards the left-hand; and by this means find them out in the heavens: And the like may be done for the finding out of any other stars, in this constellation, or of any other, from the knowledge only of but one or more stars therein.

If you suppose a line drawn from Aldebaran, to the Pleiades, and continued near double their distance farther, you will find out the triangle over the Ram (or Aries) and by that you may find out the rest of the Ram as before directed.

Or if you imagine lines drawn from the Hyades, by the north and south horns of the Bull, and continue them about double that distance, they will include two bright stars, called Castor and Pollux, in the sign Gemini; from which, and the printed constellation above, the others may be easily found out; and the like for all the rest.

2. A second way is by the passing of some of the planets, but especially the moon through the signs, or by some eminent stars, to find them out.

3. A third way to know the fixed stars, (and also the planets by) is when they come to south, and if withal you have their height given, and then by a quadrant, find their height in the heavens, you may with great certainty and ease find them out.

4. A fourth way, is by their rising and setting.

5. A fifth way to know the fixed stars, is by some instrument, or by the globes.

Of the Eclipses this present year, 1704.

This year there will be 4 eclipses, whereof two will be of the sun, and two of the moon, but none can be seen in England, but a small one of the moon, which happens upon the thirtieth day of November: Its beginning will be about a quarter of an hour past six in the morning; the greatest darkness will be at half an hour past seven; and its end at half an hour past eight a clock; and she will set eclipsed *.

Of

* Of these eclipses I find no observations.

Of the Eclipses this present year, 1705.

There will be but two eclipses this year, and both of the sun, and both of them invisible to us in England. The first of them on the 11 of May, about eight a clock in the evening. The other upon gunpowder treason day, at two a clock in the afternoon †.

The times of the Eclipses this year, 1706.

There will be four eclipses this year. The first of the moon, April 16. it begins at 5 minutes after midnight, greatest obscuration at 18 min. after one the next morning, and ends 32 min. after 2. digits eclipsed 5. The second is a great eclipse of the sun on May day†, of which see in the beginning. The third

† Of these eclipse also I find no observations on record.

‡ As accurate observations of eclipses may be of use in determining the degree of accuracy that obtains in astronomical tables; either by comparing the observations with the calculations which we find made by any one (supposing him to have calculated truly), or with accurate calculations which any person may make for that purpose; I shall subjoin, by way of notes, to every years predictions, such observations of eclipses as I find recorded in the *Philosophical Transactions*, *Leipsic Acts*, &c. And shall here begin with that on May $\frac{1}{12}$ (viz. 1st day old style, or 12th of the new) this year, it being the first I find upon record.

In the *philosophical transactions* are these following observations: which however are not the most perfect, on account of the frequent clouds which often covered the sun.

1. At Greenwich, by Mr Flamsteed.

Correct time by the pend. Clock.			
h.	m.	s.	
8	21	30	A very small part of the sun's diameter was eclipsed.
8	28	00	The chord of the arch of the sun's periphery eclipsed was 14' 40".
9	21	46	The parts of the diameter remaining clear 5' 40".
9	26	20	The same — — — — 4 30.
10	31	50	The sun appeared through the breaks of the clouds and shewed the eclipse not ended. Clouds again till
10	33	50	When the sun shone out again, we saw his limb intire, and the eclipse certainly over.

2 At

third is of the moon, Oct. 10. It begins nineteen minutes after 6 in

2. At Canterbury, by Mr S. Gray.

Correct time by the
pend. clock.

h. m.

8 53

9 08

9 31

9 36

9 55

9 57

10 02

10 04

10 14

10 16

10 20

10 30

10 31

10 36½

digits 5½ darkened.

— 7

— 10 or more

The sun shining for a short time, the eclipse
seem'd to decrease.

— 7½ a little clearer.

— 6¾

— 6

— 5¾

— 4

— 3¾

— 2½

— 1

— 0¾

The end accurately with a tube of 16 fecu.

3. At Horton near Bradford in Yorkshire, by Mr A. Sharp.

Correct time.

h. m. s.

8 35 00

9 01 00

9 04 54

9 06 33

9 07 53

9 12 50

9 16 08

9 18 48

9 20 45

9 21 48

9 28 46

9 44 45

9 54 42

10 06 18

10 19 55

10 24 00

10 30 00

digits dark 3

— 7

— 8½

— 8½

— 8½

— 9

— 9½

— 9½

— 9½

— 9½

— 9

— 7

— 5¾

— 3½

— 1

— 1 precisely.

The sun seen through clouds; the eclipse not ended.

The sun seen again perfectly round and intire.

4. At Bern in Switzerland, by Capt. Stannyan.

Captain Stannyan, from Bern in Switzerland, writes, that the sun was totally darkened there for 4½ minutes of time; that a fixed star and a planet appeared very bright; and that his getting out of the eclipse was preceded by a blood-red streak of light, from its left limb, which continued not longer than 6 or 7 seconds of time; then part of the sun's disk

6 in the evening, greatest obscuration 38 min. after 7, ends about

disk appeared, all on a sudden, bright as venus was ever seen in the night ; nay, brighter ; and in that very instant gave a light and shadow to things, as strong as moon light uses to do.

Upon this the writer of the transactions observes that

The Captain is the first man I ever heard of, that took notice of a red streak of light preceding the emerfion of the sun's body from a total eclipse : and I take notice of it, because it infers that *the moon has an atmosphere* ; and its short continuance of only 6 or 7 seconds of time, tells us, that *its height is not more than the 5 or 6 hundredth part of her diameter.*

5. At Geneva, by Mr J. C. Facis Duillier.

This gentleman could see neither the beginning nor end of the eclipse ; and all that can be collected from his account, is that the duration of the total darkness or total immersion was precisely 3 minutes ; that during the time of the total darkness, a whiteness seemed to break out from behind the moon, and to encompass it on all sides equally, its breadth being less than one-twelfth of the moon's diameter, and was but ill determined in its outward side ; that a little after the sun began to appear again, the whiteness entirely vanished ; and that several stars and planets were seen.

The same gentleman saith that, according to Mr Professor Gautier's observations, from the emerfion of the sun to the end of the eclipse, there was 1 h. 9 m. 30 s.

He also saith that the same gentleman communicated to him the following observations made

6. At Marfeilles by Mr Chazelles and Father Laval.

					h.	m.	s.
At Marfeilles the eclipse began at	—	—	—	—	8	28	40
It reached the sun's center at	—	—	—	—	9	6	11
It was total at	—	—	—	—	9	34	15
The sun began to appear again at	—	—	—	—	9	37	9
The eclipse came again to the center at	—	—	—	—	10	12	23
It entirely ended at	—	—	—	—	10	47	50

Three stars were distinctly seen ; and during 3 minutes it was not possible to read. And there remained one bright digit, all about the globe of the moon.

The manor house of Duillier is in the latitude of $46^{\circ} 24'$; in longitude it is $4^{\circ} 13' 45''$ to the eastward of the royal observatory at Paris. And St Peter's Church at Geneva is, in latitude, $0^{\circ} 12'$ to the southward, and, in longitude, $0^{\circ} 5' 2''$ to the westward of Duillier.

7. At Zurich, by Dr J. J. Scheuchzer.

We have had here, may 12, both a total and annular eclipse of the sun ; total, because the whole sun was covered by the moon ;

E

annular,

about 4 min. before 9, digits eclipsed 7 and three fourths. The fourth

annular, though not properly so called, but by refraction, for a ruddy brightness appeared about the moon, arising from the rays refracted by the moon's atmosphere.

	h.	m.
The beginning of the eclipse was in the morning	8	54
The middle — — — — —	9	58
The end — — — — —	11	12

The mora of the mean and full obscuration 4m.

Both the fixed stars and planets might be seen. The birds betook themselves to their nests. The bats came out of their holes, and the fishes swam upon the water. We ourselves perceived a sensible degree of cold, and the dew fell down upon the plants.

The following observations, of the same eclipse, are extracted from the *Leipsick Acts of the Learned*.

	8.	At	Leipsick.	h.	m.	s.
The beginning of the eclipse at about	—			9	15	0
The greatest darkness	—			10	25	20
The end	—			11	35	45
The duration of the eclipse about	—			2	21	0

There was scarcely one-third of a digit of the sun's disc uneclipsed; and several fixed stars, with the planets mercury, venus, jupiter, and saturn were visible. A shining ring was also observed surrounding the moon, parallel to its limb; it was denser in that part towards the moon, and rarer in the other part which was farthest from it; but it was, nevertheless, bounded by a very accurate periphery, and plainly to be distinguished from the uneclipsed part of the sun, which was above it towards the zenith. It was less than the uneclipsed portion of the sun's disc, and its brightness was like that of silver. The edge of the moon was pale like clouds, whilst the inner part of the disc was quite black.

9. At Jena (viz. Eysenach or Isenack, in the Marquisate of Thuringia in Upper Saxony) by professor Hambergerus.

	h.	m.	s.
The beginning — — — —	9	11	40
The middle — — — —	10	21	59
The end — — — —	11	32	18
The whole duration — —	2	20	38
The digits eclipsed 11½.			

When the darkness was greatest, he saw venus, jupiter, and capella. And so great was the darkness, that he was obliged to light a candle, in order to distinguish the minute and second pointers of his pendulum clock, which was placed in the window.

10. At

fourth is of the sun, oct. 25*. at 3 in the afternoon, invisible.
The

10. At *Berlin*.

			h. m.
The beginning	—	—	9 24'
The end	—	—	11 45
The digits eclipsed were $11\frac{1}{2}$			

11. At *Uratistavia* (viz. *Breslaw* in *Silesia*) by R. P. *Christopher Heinrich*, professor of divinity and mathematics.

				h. m. s.
The beginning of the eclipse	—	—	—	9 39 40
The beginning of total darkness	—	—	—	10 49 0
The middle	—	—	—	10 49 30
The end of total darkness	—	—	—	10 50 0
h. m. s.				
The end of the eclipse	—	—	—	12 2 20
The duration of total darkness	—	—	—	0 1 0
The duration the eclipse	—	—	—	2 22 40

The diameter of the moon exceeded that of the sun by only $15''$ of the sun's diameter.

At the time of the total darkness, several stars were very easily seen, especially two near the sun. And a circle of a faintish light surrounded the moon like a halo.

At 10 h. 6 m. 30 s. when 5 digits of the sun were darkened, a parabolic speculum, of 3 feet diameter, just set fire to dry wood; which it would not do at 10 h. 18 m. 20 s. when 7 digits were eclipsed.

At 10 h. 35 m. 30 s. when 10 digits were obscured, it just scorched a piece of rag.

At 10 h. 42 m. 0 s. when 11 digits were darkened, it would not fire any inflammable substance.

A burning lense, $9\frac{1}{2}$ inches diameter, when 9 digits were eclipsed, at 10 h. 30 m. just scorched the rag; but when 10 digits were darkened, it would no longer light any inflammable matter.

The sky, during the whole time, was remarkably serene.

* In the philosophical transactions it is recorded that

This eclipse was observed at the town of *S. Ignatius* in *Paragua*, where the altitude of the south pole is $26^{\circ} 52'$, and its merid. dist. from the R. observ. at *Paris* 3 h. 57 m. 50 s, by *F. Bonaventura Suarez*, missionary to that place.

				h. m.
Beginning of the eclipse, Nov. 5 N. S.	—	—	—	8 52 A. M.
Digits obscured	2	—	—	at 9 15
	$3\frac{1}{2}$	—	—	9 40
	4	—	—	10 0
	1	—	—	11 5
The end at	—	—	—	11 15

The greatest quantity 4 dig. at 9 h. 50 m. The times by a pendulum, rectified to true time, by the altitude of the fixt stars.

1707

The Eclipses this year.

There will be six eclipses this year. 1. A small eclipse of the sun at his setting mar. 22 invifible. 2. A total eclipse of the moon † april 6. of which fee in the beginning. 3. An invifible small eclipse of the fun on april 21, at 2 in the morning. 4. A very small eclipse of the fun fept. 14 about midnight. 5. A great eclipse of the moon at noon day fept. 30. invifible. 6. An eclipse of the fun october 14. about 3 a clock in the afternoon, but invifible to us. A famous $\delta \Upsilon \zeta$ in πx july 9 at 10 at night.

Two Arithmetical Enigmas.

1. In how long time would a million of millions of money be in telling, fupposing one hundred pounds to be counted every month, (without any intermiffion day or night, funday or work-day) till all be told?

2. If to my age there added be
One half, one third, and three times three;
Six fcore and ten the fum you'd fee,
Pray find out what my age may be?

The

† This eclipse was observed as follows :

1. At *Boston* in *New England*, by Mr T. *Brattle*.

Time corrected
by altitude.

April 5. N. S.

		h.	m.	s.	
A very notable penumbra	—	6	52	0	P. M.
The moon quite immerfed	—	8	1	15	
The moon plainly began to emerge	—	9	46	30	
The moon is fully illuminated	—	10	54	0	

2. At *Zurich*, by the two Doctors, *Scheuchzer's*.

		h.	m.	s.	
The penumbra on the fide of <i>maræotis</i>	—	12	9	18	night.
The true shadow within the difc	—	12	18	40	
The whole body of the moon in the shadow	—	1	23	20	morn.
The true beginning of the emerfion	—	3	9	40	
The penumbra	—	4	13	40	
All the moon entire	—	4	14	20	
The duration of total obfcuration	—	1	46	30	
The whole duration of the eclipse	—	3	55	50	
From the beginning to the total immerfion	—	1	4	40	
From the emerfion of the total eclipse to the end	1	4	40		3. At

1708

The Eclipses of this Year.

In this year will be four eclipses, namely, two of the sun, and two of the moon. The first is of the sun, the 11th of march, near 7 in the morning, but invisible to us. The 2d* is of the moon, march 25, about 6 in the morning: she will be above half eclipsed, but not much visible, because the sun will rise before the middle of the eclipse. The 3d † is of the sun, september 3, about 9 of the clock in the morning; it will be a visible eclipse, and about a third part of his diameter

3. At *S. Ignatius*, by the missionary *F. Bon. Suarez*.

April 16, N. S.

h. m.

Beginning — — — — 7 55 P. M.

Total obscuration — — — — 8 58

Beginning of emerfion — — — — 10 45

The end was not observed because of clouds.

* This eclipse was observed at *Paragua*, by *F. Bonaventura Suarez*, thus : 1708 april 4 P. M. N. S.

Immersion of the moon

h. m. s.

Into afensibile penumbra 12 18 0

Into the shadow — 12 30 29

Aristarchus obscured 12 13 11

Plato obscured — 12 46 0

Emerfion of the moon.

h. m. s.

Aristarchus — 14 13 15

Plato — — 14 15 0

Out of the shadow 15 3 0

Out of the penumbra 15 12 0

† This eclipse was observed at *Upminster*, by *Mr Derham*, thus :

The correct
app. time

h. m. s.

6 44 15

8 31 15

8 32 45

8 35 45

The beginning could not be seen for clouds.

The sun peeped out of the clouds, and about one-tenth of a digit was eclipsed. Then clouds most of the time. But at

A little obscuration appeared through the telescope.

A very little obscuration through the telescope.

We could discern no remains of the eclipse through the telescope.

From these observations I imagine the end of this solar eclipse was much about 8h. 33m. in the morning.

E 3

ter will be hid on the north part. The 4th * will be of the moon, september 18, near nine at night; it will be about 5 digits and a quarter eclipsed, and may be seen if the night proves clear.

A Letter to the Author.

SIR,

Readin in a book of geography the other day, I found to my great surprize, the following paradoxes.

There is a certain place in the globe, of a considerable southern latitude, that hath both the greatest and least degree of longitude.

There are three remarkable places on the globe, that differ both in longitude and latitude, and yet all lie under one and the same meridian.

There is a certain island in the baltic sea, to whose inhabitants the body of the sun is clearly visible in the morning before he rises, and likewise in the evening after he is set.

There is a certain village in the kingdom of Naples, situate in a very low valley, and yet the sun is nearer the inhabitants thereof every noon by 3000 miles and upwards, than when he either riseth or setteth to those of the said village.

There

* At Upminster Mr Derham, observed it, and records it thus :

As I was coming from London, sept. 18, in the evening, I observed, for half an hour or more, a thin shade to possess that part of the disc where the eclipse began, which remained a good while after the eclipse was over. After I got home, I got all things in readiness

The correct app. time. before the eclipse began. The principal observations were as follow :

h. m. s.			
7	56	30	A thin penumbra.
7	57	40	A darker penumbra.
7	59	0	Yet darker, which may pass for the beginning of the eclipse.
8	0	0	The eclipse no doubt begun.
9	1	0	The lucid parts of the moon, not long before the middle of the eclipse, were 925 parts of my micrometer.
9	16	40	Diameter of the moon 1634 parts of the micrometer.
10	23	11	The end of the eclipse draws nigh.
10	25	0	A little obscuration.
10	26	0	Less.
10	28	15	A very little, excepting the duskyhness before mentioned.

There is a certain remarkable place of the earth, of a considerable southern latitude, from whose meridian the sun removeth not for several days at a certain time of the year.

There are ten places in the earth distant from one another 300 miles and upwards, and yet none of them have either longitude or latitude.

These things, Sir, to me seem impossibilities; I should be glad to know your opinion of them in your next Diary.

I am, Sir, yours, &c.

The Answer.

S I R.

ALL these particulars are very true, as I shall plainly make appear in my next. *I am, Sir, yours,*

Coventry, August
the 9th, 1707.

J. T I P P E R.

The Arithmetical Questions.

In my last, I set down two arithmetical questions. The age of the person in the second question, is 66 years.* But the first Question was falsely printed, a month being put down for a minute; I have therefore here repeated it again, with four more which I have received from several parts of the kingdom.

Arithmetical Question 1.

In how long time would a million of millions of money be in counting, supposing one hundred pounds to be counted every minute without intermission, and the year to consist of 365 days, 5 hours, 45 minutes?

Question 2.

A gentleman a garden had,
Five-score foot long, and four-score broad,
A walk of equal breadth, half round
He made, that took up half the ground;
(The figure in the margin see.)
How wide's the walk pray tell to me?



Question

*The meaning of the problem is, that the number 9 added to once his age together with one-half and one-third of his age, the sum shall be 130; or, since the sum of the parts 1, and $\frac{1}{2}$, and $\frac{1}{3}$ is $\frac{11}{6}$, that $\frac{11}{6}$ of his age is $(130 - 9) = 121$; consequently $11 : 6 :: 121 : 66 =$ his age.

Question 3.

If thirteen tun of claret wine, cost nineteen english pounds;
How many pints of the same wine, are worth a thousand
crowns?

Question 4.

If thirteen marks and fourteen groats, buy fifteen loads of
hay;
How many pounds, with sixteen crowns, for ninety loads
will pay?

Question 5.

When first the marriage knot was ty'd
Betwixt my wife and me,
Mine age did hers as far exceed
As three times three, doth three:
But after ten and half ten years
We man and wife had been;
Her age came up as near to mine
As eight is to sixteen.
Now tell me, if you can, I pray,
What was our age o' th' marriage day?

1709.

*Answers to the geographical paradoxes
propounded in the last year's diary.*

Solution of Paradox 1.

ALL places that lie under the first meridian, have both the
greatest and least degree of longitude, and from any of
them you may begin or end your reckoning, let the latitude
be what it will; and the words of a considerable southern lati-
tude, are but a blind to make the question more obscure:
for as we say of the moment of time when it is noon (ac-
cording to astronomers) that it is the end of the former day,
or the beginning of the ensuing; so we may say of all places
under the first meridian, that they be the greatest number of
degrees of longitude that can be, or otherwise the beginning
and least number thereof.

Solution of Paradox 2.

By the globe is here meant the artificial globe, and the me-
ridian the brazen circle belonging thereto; then admit the
first

ter of the earth more distant from that place, than when he is in its meridian at noon. Now there being but an inconsiderable proportion between the depth of the lowest valley in the world, and the semidiameter of the earth, (which is above 3600 miles) it follows, that the sun must be 3000 miles and upwards nearer at noon, than at his rising, there being no valley the tenth part of 600 miles deep.

Solution of Paradox 5.

There are some that do say the place must be under the south pole, but I take the solution to consist rather in the equivocalness of the words from whose meridian the sun removeth not; for by this expression is not meant, that the sun stands still in the meridian, but that he constantly shines upon, or enlightens the meridian of the place, as long as he is above the horizon, which is in such places beyond the arctic circle on which the sun shines several days; as suppose in 68 deg. south lat. (for that latitude the question requires) for there the sun departs not from the meridian, *i. e.* shines upon it constantly, for 30 days together, &c.

Solution of Paradox 6.

The places are said to be in the earth and not upon it, (for longitude and latitude are reckoned upon the surface of the globe only.) So the axis of the earth (or any other imaginary line through it) being about 7200 italian miles, will not only answer the paradox; but if instead of twelve places, he had said twenty-four, it would have kept within the possibility of the demand.

Most of these paradoxes were answered by Mr Robert Winston, of Plimton, near Plymouth; and some of them by Mr Moyle, of Gwennap, in Cornwall.

Of Arithmetical Questions.

A Rithmetical questions are as entertaining and delightful as any other subject whatsoever, they are no other than enigmas, to be solved by numbers; and indeed the subtilty of numbers are so strange, that to them who are unacquainted with them, would seem impossible, and many questions, that in appearance seem a trifle, in consequence exceed all human belief. This puts into my mind a story I have read in Dr Willis's book, called opus arithmeticum. Namely, "that one Sessa an Indian having first found out the game at chess, and shew'd it to his prince Shehram; the king, who was highly pleased with it, bid him ask what he would for the reward of his invention; whereupon he ask'd, that for the first little square of the chess-board (or boards to play
" at

"at drafts on) he might have one grain of wheat given him ;
 "for the second, two ; and so on doubling continually accord-
 "ing to the number of squares in the cheffe board, which was
 "64. And when the king, who intended to give a noble
 "reward, was much displeased, that he had ask'd so trifling
 "a one; Sessa declar'd, that he would be contented with this
 "small one. So the reward he had fix'd upon, was order'd
 "to be given him : but the king was quickly astonish'd, when
 "he found that this would rise to so vast a quantity, that the
 "whole earth itself could not furnish out so much wheat.

This story the doctor believes gave rise to that new questi-
 on concerning a horse, which should be sold according to the
 number of nails in his shoes, by continually doubling of them ;
 and this likewise gave occasion to the first arithmetical question
 following, of a merchant selling some extraordinary diamonds
 being 64 in number, which I compos'd on purpose to answer
 the question propounded in the story above recited, which
 you shall have anon after I have set down

The answers to the last year's Arithmetical Questions.

Answ. to the first is, 19013 years, 144 days, 3 hours, 38
 minutes, say some; others agree in years and days, but say it
 is 5 hours 55 minutes.*

Answer to the second is, 26 feet near, or more truly
 25'96875776257.†

The

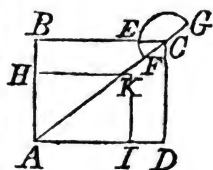
* The solution of this question is evidently thus : As 100 l. : 1 minute
 : : 1000000000000 l. : 10000000000 minutes = 19013 years 144
 days 5 hours 55 minutes, the true time required.

† This problem, I think, may be most
 elegantly constructed thus : $ABCD$ being
 the given rectangle, make $BE = BA$, and
 CF and CG (on the diagonal) each
 $= CE$; then making $AH = \frac{1}{2} AF$,
 and $AI = \frac{1}{2} AG$; and completing
 the rectangle $AHKI$, the thing is done.

For, the area $= HA \times AI = \frac{1}{2} FA \times$
 $\frac{1}{2} AG = \frac{AC - CB - BA}{2} \times \frac{AC + CB - BA}{2} =$
 $\frac{AC^2 - CB^2 - BA^2}{4} = \frac{CB \times BA}{2} = \text{half the whole area.}$

And $IA - AH = \frac{GA - AF}{2} = CF = CB - BA$,
 as it ought.

The



The number of pints in the third question are $344842\frac{2}{9}$.*

Ans. to the fourth qu. is, 49 l. 8s. besides the 16 crowns.†

The answer to the fifth and last question I received in verse,

When first the solemn knot was ty'd,

Your wife was just fifteen;

You by proportion forty-five,

Which is as three to nine.

But when your hoary head arriv'd

To ten and half ten more,

Your youthful bride saw thirty years,

And you could tell threescore.

Thus have I told without delay,

What was your age o' th' marriage day.†

Mr

The numerical calculation will come directly from the construction thus: The required breadth HB is $= BA - AH = BA -$

$$\frac{1}{2} AF = BA - \frac{AC - CB - BA}{2} = \frac{CB + BA - AC}{2} =$$

$$\frac{100 + 80 - \sqrt{16400}}{2} = 90 - \sqrt{4100} = 25.9687576256715.$$

The Algebraic Solution.

Put $a = CB$, $b = BA$, $d = a - b$, and $z = AH$. Then

$$HA \times AI = z \times z + d = \frac{1}{2} ab; \text{ hence } z = \frac{\sqrt{2ab + dd} - d}{2} =$$

$$\frac{\sqrt{aa + bb - a + b}}{2}, \text{ and } BH = b - z = \frac{a + b - \sqrt{aa + bb}}{2}$$

$$= \frac{CB + BA - AC}{2} = \text{half the semiperimeter minus half the}$$

diagonal, the same as above.

* *Quest. 3.*—As 19 l. : 26208 pints = 13 tuns :: 250 l. = 1000 crowns : $344842\frac{2}{9}$ pints.

† *Quest. 4.*—As 15 loads : 90 loads :: 1 : 6 :: 178 s. = 13 marks + 14 groats : 1068 s. = the value of 90 loads. From which deducting 80 s. = 16 crowns, leaves 988 s. = 49 l. 8s. or $49\frac{2}{5}$ l. for the number required.

† *Quest. 5.*—Put z and $3z$ for the two ages, and $a = 15$; then $2 : 1 :: 3z + a : z + a$, or $3z + a = 2z + 2a$; hence $z = a = 15$; and $3z = 45$.

But perhaps the more masterly way of solving this problem is thus : since $2 : 1 :: 3z + a : z + a$, subtract each consequent from its antecedent, and we have

$$\text{but } 1 : 1 :: z : z, \text{ hence,}$$

by subtracting, $1 : 1 :: z : a$; or $z = a =$ the number added universally.

Mr John White, of Butterly, in Devonshire, sends me word he overheard some of his plain country plow-men discoursing about the first question (of counting the money) in their country dialect, the substance whereof was as follows.

Says Tom 'twol be vorty long days,
 I and vorty to that says Will;
 'Twant be told in a year quoth Jack,
 No nor in zov'n years cries Jill;
 You talk all like vools faith Roger,
 A Merchant with's two vore veet,
 Will scrape it away in a month,
 And thereto I'll wage you a sheep;
 Go blockhead, quoth Beis, that was brewing,
 The boy that weighed my hops,
 Woll tell it all in a week,
 Zo will any mon in the shops.

All these arithmetical questions were answered by Mr John Jolly, of Buglawton, in Cheshire; Mr John Boswell, of Harlston, in Northamptonshire; Mr Robert Winston, of Plymton; Mr Micock, and W. P.

The three last by the gentleman of Modbury; and by him who stiles himself Antenor; Mr Moyl; Mr Yates, of Henly, in Arden, &c.

The difference of the answer in the first question ariseth from this, viz. That after the first division is ended, to find the number of years, one takes the remainder to be all minutes, and turns them into days, hours, and minutes directly. But the other makes the parts of the year, in the same proportion as the whole years, by multiplying the remainder, by the next inferior denomination, and dividing the product by the common divisor, &c.

The eclipses of this year.

This year there ~~will~~ be two eclipses, and those both of the sun. The first is a small visible eclipse, on the 28th of february, about noon, or rather a little after; the digits eclipsed are 3. The second is on the twenty-fourth of august, it will be a great eclipse, but to us invisible, it happening to be about one a clock in the morning.*

These eclipses happening the one before, and the other after the suns apogæon, there can be no full-moon eclipse this year

New

* From F. Bonaventura Suarez's observation of this eclipse at Paragua, it appears that the eclipse ended at 7 h. 37 m. 15 s. and that the greatest obscuration was $9\frac{1}{4}$ digits. He saith, the sun rose at 5 h. 53 m, and that the eclipse had begun before then.

New Questions.

I Question 6.

A rich indian merchant, had diamonds good store
 Of extraordinary value, in the whole sixty four;
 Who brought them to sell to a persian king,
 Who ask'd him the value each diamond would bring:
 Quoth he for the first stone, I will have but one grain
 Of your best indian wheat, for the next, I'll have twain;
 For the third, I'll have four grains, and for the fourth, eight;
 So doubling the last sum, till all are complete.
 Done! done! (saith the king,) with a great deal of pleasure,
 Who thought for a trifle he had purchas'd a treasure;
 And calls for, (jocosely) a bag of wheat out,
 Saying count, for there's more than enough without doubt.
 But when for some hours, the grains they did count,
 They found to such vastness the whole would amount,
 That all the whole kingdom, and several more,
 Could not yield so much corn as would pay of the score.
 The king being pleas'd with the merchants great wit,
 Gave him good store of gold for his bargain to quit.

Propose now each bushel of wheat worth a crown,

And just half a hundred did weigh:

And suppose a corn-pint held ten thousand wheat grains;

These two questions answer I pray.

- (1.) What number of horse loads (* thousand pounds each),
 Must be us'd to support this great treasure?
- (2.) And how many ships, each a hundred tun freight,
 Would suffice to transport the wheat hither?

II Question 7.

Quoth Jack to Tom, your Age and mine

Are both the same; and Valentine

My eldest son's just half my years,

(As by the register appears.)

If these three sums you multiply

One in another continually,

And to their product (drawn at length)

Add five times sixty-eight, one tenth; (i. e. $340\frac{1}{10}$)

The whole to thirtythousand will amount,

What is each age? come try your skill and count?

III Question 8

A vint'ner would mix three sorts of wine

Of various rates; the first was very fine,

The price eight groats the quart; the other two

Were

* Sterling silver money.

Were five and four groats each, now he would brew
 Fifty six quarts together, in such sort
 To sell't for two and twenty pence a quart:
 How many answers in whole numbers may
 Be found to solve the question ; tell me pray ?

IV *Question 9.*

Sev'n men did buy a grinding-stone,
 Of five foot in diameter:
 And they agree among themselves,
 That each shall grind an equal share,
 And that one man should first begin
 To grind his seventh part off the stone ;
 And then another should grind his,
 And so continue one by one.
 How much each man for's part must grind ?
 Is what you are requir'd to find ?

V *Question 10.*

Those pendulum clocks, by experience is found,
 Whose swing in a minute, make sixty rebounds,
 (As by tryal you'll find if you measure their lengths,)
 Will contain just thirty nine inches, two tenths.
 If so ; then how long must that pendulum be,
 That shall make the same number of swings to agree
 With the number of inches its length doth contain,
 (In the space of a minute ;) I'd know very fain ?

1710.

*Solutions to the last year's questions.**Solution of question 6, by a Lady.*

Suppose, (saith she) navigation to have begun with Adam,
 and 67279 ships of 100 tun each to have been built every year
 since the creation of the world, (which she supposes to be
 about 5655 years;) and so to build the same number conti-
 nually to the end of the world, and the world to last 5000
 years longer, and all those ships to be in being at once ; all
 of them together (according to the tenour of the ques-
 tion) would not be sufficient to transport the wheat, so pro-
 digious is the quantity. She adds,

For th' horses must be (as sure as your alive)
 Of millions, sev'n thousand, two hundred, and five ;
 Of thousands, sev'n hundred, fifty, and nine ;
 Of units four hundred, and three ; (very fine !)

To

To carry the cash, fir; and then 'tis as plain
 Just so many ships will bring o'er the grain.
 I shall not stand much on the fractional part;
 E'en take it i' the bargain with all my heart.
i. e. 7205759403 horse loades, (besides 792*l.* 15*s.* 10*d.* odd
 money,) and the same number of ship-loads.*

Solution of question 7.

If thirty nine you multiply by thirty nine, 'tis plain,
 That fifteen hundred twenty one you by that work will
 gain;
 This drawn into nineteen, five tenths, the age of his first
 son,
 To th' product add the *sum propos'd, and $\frac{*340}{10}$
 so the work is done.
i. e. Jack and Tom's age is 39 years each and Valentine's 19
 years and an half.†

Solution of question 8.

To mix the wine as you propose, there are no other ways
 but those,
 Which are below in order plac'd, and had with jingling
 rhyme been grac'd,
 Would they not too much paper waste: besides, I'm now,
 fir, in great haste.
 Best 10 11 12 13 14 15 16 17 18 19 20 quarts at 32*d.* each
 Mean 44 40 36 32 28 24 20 16 12 8 4 quarts at 20*d.* each
 Worst 2 5 8 11 14 17 20 23 26 29 32 quarts at 16*d.* each
 Being

* *Solution of QUESTION 6.* The number of terms being 64, the
 ratio 2, and the first term 1; the sum of all the terms of the series
 will be $\frac{2^{64} - 1}{2 - 1} \times 1 = 2^{64} - 1 = 18446744073709551615$ for
 the number of grains of wheat; which being divided by 10000 \times
 64 = 640000 the number of grains in a bushel, we have
 28823037615171.1743984375 for the number of bushels; the
 value of which at 5*s.* each is 7205759403792.79 &c. *l.* and the
 double of this number will be the weight in *cwts.* then the value
 divided by 1000, and the weight by 2000, give each 7205759403.79
 &c. for the number of horse or ship loads required.

† *QUESTION 7.* This question is to find three numbers, of
 which two shall be equal to each other, and each double of the
 third, and whose continual product shall be (29659.5) 340.5 less
 than 30000: or, to find two numbers, the one double the other,
 and the less multiplied by the square of the greater shall produce
 29659.5: or, to find a number, the half of whose cube shall be
 29659.5, or its whole cube 59319; and consequently that number
 must be $\sqrt[3]{59319} = 39 =$ the age of each of the elder; and conse-
 quently 19½ is that of the youngest.

Being eleven answers in whole numbers, which are all that can be found to fell 56 quarts, at 22d. a quart.*

Solution of question 9.

How to divide the grinding-stone	1st.	4'4508
Which sev'n men grind down one by one?	2d.	4'8400
Look in the margin, and you'll find	3d.	5'3535
What each man for his part must grind.	4th.	6'0765
(I mean, what each man for his share	5th.	7'2079
Must grind of the diameter:)	6th.	9'3935
Which being added all in one	7th.	22'6778
Do make up the first given sum.†		60 Inches.

Solution of question 10.

If the learn'd Ricciolus believed may be
When he tells you, reciprocal, pendulums be
To each others length, as their squares of vibration
Made up in the same time (without variation,)

Then

* QUESTION 8. Putting x , y , and z for the number of quarts of the best, middle, and worst sort, respectively; then $x + y + z = 56$, and $32x + 20y + 16z = 22 \times 56 = 1232$; hence $z = 3x - 28$, and $y = 84 - 4x$. Now x must be such a whole number as will make both $3x - 28$ and $(84 - 4x)$ or $21 - x$ whole numbers; from the latter of these two equations, it appears that the greatest value of x is 20; and from the former, that its least value is 10: so that x may be any number from 10 to 20 inclusive; and by substituting every number from 10 to 20 for x , in the two equations $z = 3x - 28$, $y = 84 - 4x$, we obtain these eleven answers in whole numbers; viz.

$x = 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20$, quarts at 32d. each.
 $y = 44, 40, 36, 32, 28, 24, 20, 16, 12, 8, 4$, quarts at 20d. each.
 $z = 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32$, quarts at 16d. each.

† QUESTION 9. This question is to divide a circle, of 60 inches diameter, into 7 equal parts, or rings, bounded by concentric circles; of which the solution will be thus.—The whole circle, and each inner circle, after the several preceding rings are ground off, must be to each other, by the question, as the numbers 7, 6, 5, 4, 3, 2, 1; but circles are as the squares of their diameters; therefore the diameters of those circles will be to one another as $\sqrt{7}$, $\sqrt{6}$, $\sqrt{5}$, $\sqrt{4}$, $\sqrt{3}$, $\sqrt{2}$, $\sqrt{1}$: but the greatest diameter is 60 or $60\sqrt{\frac{7}{7}}$; therefore, by proportioning, all the other diameters will come out thus, $60\sqrt{\frac{6}{7}}$, $60\sqrt{\frac{5}{7}}$, $60\sqrt{\frac{4}{7}}$, $60\sqrt{\frac{3}{7}}$, $60\sqrt{\frac{2}{7}}$, $60\sqrt{\frac{1}{7}}$. Now the last of these is the diameter of the last person's share, and the difference between every two adjacent terms being taken, will give the double breadth of the rings, or the parts of the whole diameter to be ground off by the other persons; viz.

Then fifty two inches, six cents, something o'er
Will answer this question: fo provide for some more.

i. e. 52'06303991625185108271 being the cube-root to
20 Decimals.* Every

$$60\sqrt{\frac{7}{7}} - 60\sqrt{\frac{6}{7}} = \frac{\sqrt{7} - \sqrt{6}}{\sqrt{7}} \times 60 = 4'450794 \text{ the 1st person's share}$$

$$60\sqrt{\frac{6}{7}} - 60\sqrt{\frac{5}{7}} = \frac{\sqrt{6} - \sqrt{5}}{\sqrt{7}} \times 60 = 4'839951 \text{ the 2d}$$

$$60\sqrt{\frac{5}{7}} - 60\sqrt{\frac{4}{7}} = \frac{\sqrt{5} - \sqrt{4}}{\sqrt{7}} \times 60 = 5'353518 \text{ the 3d}$$

$$60\sqrt{\frac{4}{7}} - 60\sqrt{\frac{3}{7}} = \frac{\sqrt{4} - \sqrt{3}}{\sqrt{7}} \times 60 = 6'076516 \text{ the 4th}$$

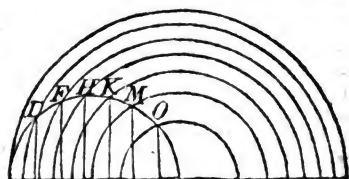
$$60\sqrt{\frac{3}{7}} - 60\sqrt{\frac{2}{7}} = \frac{\sqrt{3} - \sqrt{2}}{\sqrt{7}} \times 60 = 7'207871 \text{ the 5th}$$

$$60\sqrt{\frac{2}{7}} - 60\sqrt{\frac{1}{7}} = \frac{\sqrt{2} - \sqrt{1}}{\sqrt{7}} \times 60 = 9'393480 \text{ the 6th}$$

$$60\sqrt{\frac{1}{7}} - 60\sqrt{\frac{0}{7}} = \frac{1}{\sqrt{7}} \times 60 = 22'677870 \text{ the 7th}$$

the sum of them all is 60'000000 the whole diameter.

The CONSTRUCTION
will be thus.—Divide the radius AB of the given circle into 7 equal parts; and at the points of division erect perpendiculars meeting the circle, described on the diameter AB , in D, F, H, K, M, O ; $BCEGILNA$



then with the center A , and radiuses AO, AM, AK , &c. circles being described, the thing is done.—For, by the nature of the circle, the squares of the chords or radiuses AO, AM, AK , &c. are as the versed sines AN, AL, AI , &c.

SCHOLIUM. It is evident that the above method of calculation and construction will both hold true also when the shares are unequal in any proportion; by using the respective proportional numbers in the former, and dividing the radius AB in the same proportion in the latter.

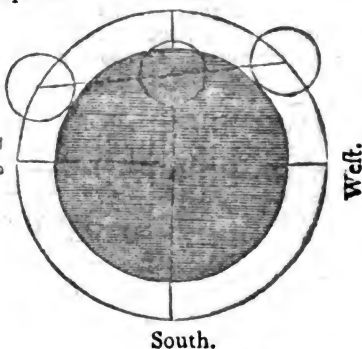
* **QUESTION 10.** Since the lengths of different pendulums are to each other reciprocally as the squares of their vibrations made in the same time; we shall have, putting x for the length required, $x : 392 :: 60^2 = 3600 : xx$; hence $x^2 = 3600 \times 39^2$, and $x = \sqrt{3600 \times 39^2} = \sqrt{141120} = 52'06304$ inches, nearly.

Every one of these questions were answer'd by Mrs Mary and Mrs Anne Wright, before named; and by Mr Tho. Markham, of King's-lyn (who answer'd the 10th qu.) four of 'em were answer'd by Mr Fr. Walker, of Lyn-regis, Mr Hen. Beighton of Griff. Mr Amos Fish. The 6th, 9th, and 10th, were answer'd by Mr John Richards, Mr Rob. Salter, of Topsham; and Mr Abr. Symmonds, Mr Hen. Carter, Mr John Boswell, Mr John Mark, and Mr Rob. Whittle, answer'd one or more of them.

The eclipses of this year.

The two great lights of heaven, the sun and moon, will each this year be twice eclipsed. North.

The first is an eclipse of the moon upon the second day of february; being candlemas-day, betwixt the hours of ten and eleven at night, and, if the air be clear, will be visible to us: near ten parts of the twelve of the moon's diameter will be obscured, by the shadow of the earth, on the south part of her body, according to the type here in the margin.

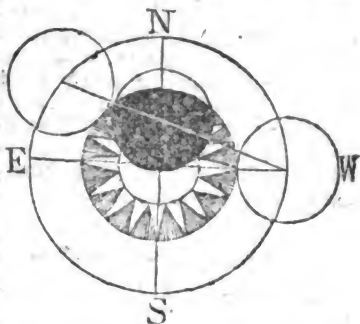


	h.	m.	s.
To the inhabitants of the city of Coventry } the beginning of this eclipse will be at	8	54	58 p. m.
The true opposition is at	10	16	37
The middle of the greatest obscuration at	10	21	41
The end of the eclipse at	11	48	24
Total duration will be	2	53	26
The digits eclipsed	9	56	43 south.

	m.	s.	
Latitude of the moon at the { beginning	38	48	{ north descen.*
{ end	29	19	{
			The

* This eclipse was observed by Mr H. Gressener at Streatham, about 6 miles almost directly south of London, with a very good 8 foot telescope, the time by his clock being accurately corrected from Mr Flamstead's observations. He says that, the time of the end, (which was what alone the want of a proper apparatus, and a favourable sky, would give me leave accurately to determine) I found

The second eclipse is of the sun, upon feb. 17, near 1 in the afternoon, and will (if the air be clear) appear to us in England, a considerable eclipse; for more than two third parts of the sun's body will be darkened, on the north part: (see the type in the margin.) It will be a great and central eclipse in divers parts of the world, but by reason the sun's diameter exceeds that of the moon, there will appear a bright circle of the body of the sun encompassing the moon on all parts (as it did at Rome on the 9th of April, 1576.)



	h.	m.	s.	
The begining of this eclipse, to the inhabitants of the city of Coventry, will be at	11	12	17	mane.
The greatest obscuration at	—	—	—	0 42 58
The visible conjunction at	—	—	—	0 45 11
The end at	—	—	—	2 10 18
Total duration is	—	—	—	2 58 1
Digits eclipsed	—	—	—	8 8 36 north

	m.	s.	
Moon's latitude seen at the {beginning	0	17	south
{end	16	57	north
			ascend.

The third will be an eclipse of the moon, on the 19th day of july, between 9 and 10 a clock in the morning, therefore not visible to us: she will be 9 digits 13 min. darkened.

The last is an eclipse of the sun, on august 13, near 6 of the clock

to be the same (with but a very inconsiderable difference) which the calculation, according to Sir Isaac Newton's admirable theory, promised me to expect.

He then puts down the calculations at large, both according to Sir Isaac's theory, and that of Mr Horrox; the result of which is that he finds

	h.	m.	s.
The end of the eclipse by the moon's place from	12	2	0
Sir Isaac Newton's theory	—	—	—
The end by Horrox's theory	—	—	—
The end by observation	—	—	—
	12	1	30

The error therefore of Sir Isaac's theory is, by this observation, but half a minute, or none; of Horrox's system, nine minutes and a half.

clock in the afternoon: and though the sun be then, to us in Great-Britain, an hour high, yet the moon's south latitude being great, and being increased by her south parallax, doth depress her too low, as to interpose between the sun and us, or indeed of any part of Europe. But in the southern parts, it will be both total and central, and formidable to behold, and in the latitude of 6 deg. 56 min. south, and longitude 138 deg. 3 min. west from Coventry. This eclipse begins at sun rising, in lat. 30 deg. 13 min. S. and long. 151 deg. 54 min. west from Coventry he will be centrally eclipsed at sun rising. In lat. 41 deg. 14 min. S. and long. 105 deg. 59 W. from Coventry, he will be centrally eclipsed in the nonagesim. deg. in 76 54 S. and long. 64 57 W. from Coventry, he will be centrally eclipsed at sun setting: and in lat. 57 26 S. and long. 148 W. from Coventry the eclipse ends at sun setting.

Some geographical paradoxes proposed to the ingenious, to be solved against next year.

1. **T**HERE are two remarkable places in the globe of the earth, in which there is only one day and one night throughout the whole year.

2. There are also some places on the earth, in which it is neither day nor night at a certain time of the year, for the space of 24 hours.

3. There is a certain place of the earth, at which, if two men should chance to meet, one would stand upright upon the soles of the other's feet, and neither of them should feel the other's weight, and yet both should retain their natural posture.

4. There is a certain place of the earth, where a fire being made, neither flame nor smoke would ascend, but move circularly about the fire. Moreover, if in that place one should fix a smooth or plain table without any ledges whatsoever, and pour thereon a large quantity of water, not one drop thereof could run over the said table, but would raise it self up in a large heap.

5. There are three remarkable places on the continent of Europe, that lie under three different meridians, and yet all agree both in longitude and latitude,

6. There is a certain island in the Ægean sea, upon which, if two children were brought forth at the same instant of time, and living together for several years, should both expire on the same day, yea, at the same hour and minute of that day, yet the life of the one would surpass the life of the other by divers months!

New

New Questions.

I Question 11.

A man being asked what cash he'd in store?
 Reply'd, I have three sorts of coin, and no more.
 I have six-pences, shillings, half crowns; now to shew
 The whole sum that I have, by this means you may know:
 If the shillings and six-pences both you do join
 In one sum, they will make just four hundred and nine:
 If the shillings and half crowns together you count,
 The number of both you will find to amount
 To one thousand, two hundred, fifty and four,
 (Which clears up the case something more than before.)
 But if you from the half crowns and six-pences take
 Four times ten, and twice one, the remainder will make
 One thousand, one hundred and three. Now from hence
 You may tell what I have in pounds, shillings and pence..

II Question 12.

A gentleman was by agreement to pay
 One thousand pounds just, and no more;
 And he had none other but two sorts of gold,
 Which were *guineas and †luidores. * Of 21s. 6d.
 How many of each must he give to defray † Of 17s.
 His said debt, and how many ways might he pay
 This said sum by these two only coyns, tell me, pray?

III Question 13.

A farmer with a plowman doth agree.
 That thirty days his servant he should be.
 Each day he wrought, the farmer is to pay
 Him sixteen pence; but when he is away,
 Five groats he is for each day to abate:
 The time expir'd, they their accompts do state,
 Whereby the master nothing is to give,
 Nor has the servant any to receive.
 How many days he wrought I do demand,
 And how many he play'd I'd understand?

IV Question 14.

In the midst of a meadow well stored with grass,
 I took just an acre to tether my horse:
 How long must the cord be, that feeding all round,
 He mayn't graze less nor more than his acre of ground?

V Question 15.

A country spark address'd a charming she,
 In whom all lovely features did agree:
 But he not skill'd i'th' art (you may presage,)
 Was too solicitous to know her age.

The.

The lady smil'd at this prepos't'rous rule
Of courtship: but to satisfy the fool,
Made him this answer with a gen'rous air
(A lofty charm peculiar to the fair,)

" My age is that, if multiply'd by three,
" And two sev'nths of that product trebb'l'd be,
" The square-root of two ninths of that is four:
" And now farewell—I'll never see you more.
" Your fond impertinence has caus'd this rage:
" 'Tis clownish fure to ask a woman's age.
So you're desir'd t' assist him, or perchance
The spark must still remain in ignorance.

Question 16, by way of letter.

London, May the first, 17 hundred and 9.

Dear friend,

I make bold for to send you a line
T' inform you what hapt to me this very day:
As I pass'd with some friends thro' cheapside, in our way
We were viewing Bow-steeple, says a spark that stood by,
Can you tell, sir, by art, how many feet that is high?
" I'll lay you I can, sir, a piece to be spent:
" 'Tis done, quoth the spark: I reply'd, " I'm content.
We laid down our money. The sun shining plain,
I measur'd the shadow, which I found to contain
Two hundred fifty three feet, half a quarter,
And the clock just struck twelve as I finish'd the matter.
Now (good sir) inform me, how high is the steeple?
For you can't beat it into my head with a beetle
How it is to be done:—Were the wager to find, Sir,
A pritty plump girl, or a good glafs of wine, sir,
I think I could do it as well as the best;
But these crabbed hard numbers I ne'er could digest.
Fail me not in this pinch, sir, whatever you do,
If you should, my dear money away I shall throw:
Besides, all my friends, sir, will laugh at me too.

}

1711.

*Answers to the geographical paradoxes propounded in the last year's diary.**Solution of Paradox 1.*

The places lie under the two poles,

Solution of Paradox 2.

The places must be 90 degrees from the sun when he is in or near the tropicks. Thus, if the sun is in the tropick of capricorn, the places then will be under the artic-circle, or rather 15 minutes (being the semediameter of the sun) more north, for then it is day, because the sun is below the horizon: nor is it night, because by the refraction of the atmosphere the sun to the inhabitants of that place will seem to be really risen. The reason of such refraction I gave you in my diary of 1709.

Solution of Paradox 3 and 4.

Is the center of the earth.

Solution of Paradox 5.

By Mr Robert Willon, to this effect, viz. Divers geographers begin their first meridians at divers places. Thus Ptolemy at Cape Verd, (formerly one of the fortunate islands.) Mercator, at St Michael's in the Azores. Blaew, at Teneriff in the canary-islands, &c. Now if you take (under the same lat.) 3 places (suppose 10 degrees) from each of these first meridians, they agree all in lat. and also in long. from those 3 respective places, and yet lie under 3 different meridians, in respect of the globe.

Solution of Paradox 6.

Mrs. Lydia Fisher answers it thus: if one of the children sails directly east, and the other directly west, when they encompass the globe of the earth once (which is now easily done in a year) there will be two days difference in their age. And in 40 years thus sailing, the one would be 80 days older than the other.

Mr Mark Moyle answers it thus: suppose the one lives within the artick Circle (where no day exceeds 24 hours) and the other goes and lives in the parallel of lat. (suppose of 73) deg. 20 min. where the day is 3 months long. and then returns, and both die; the one will be three months older than the other—These were answer'd also by Mr Leadbetter, Mr. John Senhouse, Mr. Will. Davenport.

Solu-

Solutions to the last year's questions.

* I. *Question 11. answered by Mr. Tho. Gosling.*

The answer will be, as sure as you're alive,
Of half crowns nine hundred ninety and five,
Of shillings two hundred fifty and nine,
Of sixpences sev'n score and ten (very fine:)
Which added together, the whole comes from thence
To one hundred forty one pounds, eighteen pence.

i. e. 995 half crowns, 259 shillings, 150 sixpences, in all
141l. 1s. 6d.

† II. *Question 12. answered by Mr. John Boswel.*

To pay the debt as you propose,
There are no other way than those
Which here below doth plain appear,
In number sev'n and twenty are.

Guineas—32. 66. 100. 134, &c. by adding always 34.
Lewidores—1136. 1093. 1050. 1007, &c. by stubtr. always 43
will give 27 answers, each two sums making 1000l.

Question

* I. *QUESTION 11. solved.*

The meaning of this question is that the sum of the shillings and sixpences is 409, the sum of the shillings and half-crowns is 1254, and the sum of the sixpences and half-crowns 1145; to find the number of each. That is, having given the sums of every two of three numbers, to find the numbers.

Put x = the number of sixpences, y = the shillings, and z = the half-crowns. Then, by the question, $x + y = 409$, $y + z = 1254$, and $x + z = 1145$. The sum of the first and third, is $2x + y + z = 1554$, from which taking the second, we have $x = 300$; hence $x = 150$, $y = 409 - x = 259$, and $z = 1145 - x = 995$. And the sum of these all together amounts to 141l. 1s. 6d.

† II. *QUESTION 12. solved.*

Put x for the number of guineas, and y for that of the louis-d'ors. Then will $43x + 34y$ be $= (1000 \times 40 =) 40000$; hence $y = \frac{40000 - 43x}{34} =$ (by dividing) $1176 - x - \frac{9x - 16}{34}$; conse-

quently $\frac{9x - 16}{34} =$ a whole number, as also 4 times the same,

viz. $\frac{36x - 64}{34} = \frac{18x - 32}{17} =$ (by dividing) $x - 2 + \frac{x + 2}{17}$;

hence $\frac{x + 2}{17} =$ a whole number $= p$; then $x = 17p - 2$.

Mathem.

G

This

* III. *Question 13. answered.*

That lazy drone, who squander'd away,
 Thirteen days, and one third, in sleep and play,
 In thirty days (for all he nothing got)
 Deserv'd to have his bones broke, for an idle sot.
 i. e. He work'd 16 days 8 hours, and play'd 13 days 4 hours.

† IV. *Question 14. answered by Mr. Nat. Browne.*

If you be dispos'd, sir, to tether your horse
 In a meadow that's very well stored with grass,
 That just he may graze up an acre of ground,
 The length of the cord may hereunder be found.

viz. 39 Yards. 2507375.

‡ V. *Question 15. answered by Mr. John Ford.*

Young maids oft speak their minds with words so dark,
 That leaves a doubtful meaning on their spark;
 Else she might surely without words so plenty,
 As well have said her age was eight and twenty.

Question

This written for it in the expression $y = \frac{40000 - 43x}{34}$, gives $y = 1179 - 21\frac{1}{2}p$; consequently $p = \text{any even number} = (\text{suppose}) 2n$; then $y = 1179 - 43n$, and $x = 34n - 2$; where n is any integer number.

Taking successively the numbers 1, 2, 3, 4, &c. for n , we have
 $x = 32, 66, 100, 134, 168, 202, 236, 270, 304, \&c.$
 $y = 1136, 1093, 1050, 1007, 964, 921, 878, 835, 792, \&c.$

* III. *QUESTION 13. solved.* Since the two products of each number of days by their respective prices are equal to each other, it follows that the said number of days will be reciprocally as the prices; but the prices are as 20 to 16, or as 5 to 4, whose sum is 9, and the whole number of days is 30; whence $9 : 30$ or as $3 : 10$
 $\therefore \begin{cases} 5 : 16\frac{2}{3} \text{ days worked.} \\ 4 : 13\frac{1}{3} \text{ days idled.} \end{cases}$

† IV. *QUESTION 14. solved.* The number of square yards in an arce being 4840, and a circle being equal to $3\cdot14159 \&c.$ drawn into the square of the radius; therefore $\frac{4840}{3\cdot14159 \&c.} = \text{the square of the radius, and consequently the radius itself or length of the chord will be } \sqrt{\frac{4840}{3\cdot14159 \&c.}} = 39\cdot25073 \text{ yards.}$

‡ V. *QUESTION 15. solved.* Put x for the lady's age. Then, by the question, $\sqrt{3x \times \frac{2}{7} \times 3 \times \frac{2}{9}} = \sqrt{\frac{36x}{63}} = 4$; hence
 $x = \frac{16 \times 63}{4} = \frac{16 \times 7}{1} = 4 \times 7 = 28.$

* *Question 16. being the Prize Question, answered by Mrs. Mary Wright, to whom I presented the 12 diaries, according to my promise. I will give it you in her own words :*

May 1, 1709.

Sun's longitude, from its ingress into aries	—	51° 28' 0"
Oblique angle of the ecliptick and equator	—	23° 29' 0"
Thence the declination that day	—	18° 9' 45"
Consequently its merid. altitude in lat. 51° 32'	—	56° 37' 45"
The complement thereof to 90 is	—	33° 22' 15"

Then as the sine of the angle 33°. 22'. 15".

To the base 253. 125 feet,

So is the sine of the angle 56. 37. 45.

To the perpendicular 384. 307 feet the height of the steeple.

Note, The true height of Bow steeple is 225 feet, for which at first I had proportioned the length of the shadow, but upon second thoughts I alter'd it, for fear some, who had read its height in history, should claim the reward, without having art enough to investigate it by trigonometry.

The answer to the person that sent the 16th question.

Sir, Yours I received, and finding you are

A pleasant companion, and kind to the fair,

I thought myself bound to assist you in this;

When to London I come you won't take it amiss,

If I give you the trouble to shew me your skill

In choosing a bottle, or a fair one that will.

To save then you coin, and prevent your friends laughter, }

Three hundred eighty four feet and a quarter }

Is the height of the steeple, within a small matter.

I received divers other answers in verse, from divers other persons, but have not yet room to repeat them.

The

* VI. PRIZE QUESTION 16. solved.

This solution, at length, will be thus :

The sun's longitude being supposed 51° 28', and the angle made by the equator and ecliptic 23° 29' ; by right-angled spherical triangles, as radius : sine of 51° 28' :: sine 23° 29' : sine 18° 9' 45" the declination for the time; to which adding 38° 28' the complement of the latitude, there results 56° 37' 45" for the meridian altitude that day. Then, by right-angled plane triangles, the height of the steeple will be found by Mrs. Wright's proportion above, or rather thus, as radius : tang. 56° 37' 45" :: 253½ : 384.31 the steeple's height.

The eclipses of this year 1711.

Six times this year will the two great lights of heaven be eclipsed, namely four times the sun, and twice the moon.

The first is of the sun, on the 7th of january, 3 quarters of an hour after 9 at night; and, tho' invisible to us, about 3 deg. eastward in longitude from Coventry (where it is greatest) the sun will set about 3 digits eclipsed, on the south side of it.

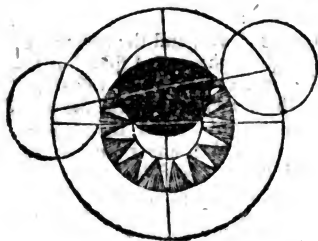
The second is of the moon, a great and total eclipse on 23d of january, near noon, and so invisible to us; but will be visible near the meridian of our antipodes. It begins at Coventry at 27 min. 29 sec. after 10 in the morning; the immersion is at 26 min. 30 sec. after 11; the middle at 13 min. 10 sec. afternoon; the true opposition at 14 min. 24 sec. afternoon; the emerision at 59 min. 51 sec. afternoon: the end at 58 min. 52 sec. after 1. The total duration 3 hours 31 min. 23 sec. digits eclipsed 19 and near a quarter.

The third is a small eclipse of the sun, on the 6th of february at 1 ho. 11 min. 56 sec. in the afternoon, but cannot be seen by reason of the great north latitude of the moon, except under the artick circle, where it is most conspicuous, and about 78 deg. westward in long. from Coventry; at sun-rising, the south limb of the moon will touch the northern limb of the sun a little more than a quarter of a digit, or the 48th part of the sun's diameter, and therefore will hardly be perceptible.

The fourth will be an eclipse of the sun, on wednesday the 4th of july, near 7 in the afternoon; and, if the air be clear, two third parts of the sun's diameter will be seen to be darkened on the north side.

			h.	m.	s.	
The beginning is at	—	—	7	3	46	} p.m.
The visible conjunction	—	—	7	53	51	
The greatest obscuration	—	—	7	55	52	
The end	—	—	8	45	40	
The duration	—	—	1	41	54	
The digits eclipsed	—	—	8	35	40	

Moon's latitude seen at the	Beginning	12	33	} Nor.
	End	4	14	



This eclipse, where greatest, can be but nine digits and an half, and that at sun-setting under the artick circle, and longitude about 48 deg. east from us.

The

The fifth is a total eclipse of the moon on july 18, at near 6 in the afternoon, but not visible to us, because the eclipse ends 10 min. before the moon rises. The beginning is at 4 ho. 6 min. 34 sec. after noon. Immersion at 5 h. 7 m. 37 f. Middle at 5 h. 51 m. 26 f. True opposition at 5 h. 53 m. 24 f. Emer-sion at 6 h. 35 m. 15 f. The end at 7 h. 36 m. 18 f. Duration 3 h. 29 m. 44 f. Digits eclipsed 17 and an half.

The last is of the sun on the 28th of December at 9 h. 39 m. 53 f. in the morning, but by reason of the moon's south lat. augmented by her south parallax, it cannot be seen by us, altho' the sun is above the horizon, but will be both total and central in the southern parts of the world.

Two geographical questions proposed against next year.

Question 1.

In what degree of latitude
Does that soft female dwell,
Who upon certain days might view,
If she observeth well,
The morning sun on th' self same point
Of compas twice to be,
Likewise his evening azimuth
Twice in the same degree.
Tell me sweet english ladies, for you are
Than her more charming far, and far more fair.

Question 2.

In the Atlantick ocean from our shore
Distant five hundred leagues, or little more,
Lies the canary isles, blest with good air,
Sweet whistling birds, rich wines beyond compare:
A mountain, the world's wonder's situate there,
One of the highest in this earthly sphere:
By us 'tis call'd the teneriffa's pike;
Whose lofty head i'th' atmosphere's so high,
That it surmounts all grosser clouds o'th' sky.
Three degrees and an half, you may it ken,
Or, (what's the same) two hundred miles and ten;
For the refraction angle, you may make
Allowance, (what is thought but meet to take);
Thirty five minutes just, of a degree.
Now I demand what heighth the pike must be?

New Arithmetical Questions.

I. *Question 17.*

I happen'd one ev'ning with a tinker to sit,
 Whose tongue ran a great deal too fast for his wit:
 He talk'd of his art with abundance of mettle;
 So I ask'd him to make me a flat-bottom kettle,
 That the top and the bottom diameters be
 In just such proportion as five is to three:
 Twelve inches the depth I would have, and no more,
 And to hold in ale gallons seven less than a score.
 He promis'd to do't, and to work he strait went;
 But when he had done it, he found it too scant.
 He alter'd it then, and too big he had made it,
 And when it held right, the diameters fail'd it:
 So that making't so often, too big, or too little,
 The tinker at last had quite spoiled the kettle:
 Yet he vows he will bring his said purpose to pass,
 Or he'll utterly spoil ev'ry ounce of his bras.
 To prevent him from ruin, I pray help him out,
 The diameter's length else he'll never find out.

II. *Question 18, by Mrs. Lydia Fisher.*

What two sums are those, can any suppose,
 If added together they must
 Make twelve-pence, be sure, and nine halfpence more,
 (Or sixteen-pence-halfpenny just?)
 But if by division you make a decision,
 And the greater by th' lesser divide;
 In the quotient will rest sev'n and twenty pence just:
 Come, ladies, this riddle decide.
 And to find out these numbers without any blunders,
 Pray tell me what course you will take:
 And if you can do it, and to the world shew it,
 Amends, when I meet you, I'll make.

III. *Question 19.*

Pray try your skill two numbers for to find,
 Whose sum, when added, will be just one sev'nth; ($\frac{1}{7}$)
 And if together they be multiply'd,
 Their product's four eight hundred forty sev'nths. ($\frac{4}{147}$)
 Fractions are called numbers here, you see,
 And your true answer will two fractions be.

IV. *Quest-*

IV. *Question 20, by Mr. William Hawney.*

A famous general having serv'd his king
 Long time in wars, and had victorious been;
 For which his service (with a pleasant smile)
 Ask'd of his king one farthing for each file
 Of ten men in a file, which he could then
 Make with a body of one hundred men.

The king considering his brave actions past,
 And seeming modesty of his request,
 Gave his consent: ———To what will it amount
 In sterling money? Take your pen and count.

V. *Question 21. by Mr. Gideon Cosier.*

A gentleman, as he did ride,
 Near to a pleasant common side,
 Some shepherdesses chanc'd to meet,
 Driving their flocks, whom he did greet.
 God speed you well; and may you be
 As happy as you're fair, (quoth he:)
 Prosper your flocks, and may they thrive:
 Tell me how many sheep you drive?
 One of the damsels streight reply'd,
 Sir, you shall soon be satisfy'd,
 For if the flock we should divide
 Among us equally, each share
 Is twice the number we maids are:
 But if for one of us you do
 Count one sheep, for the next count two,
 For the third four, for the fourth eight,
 So doubling at each maid aright,
 At the last maid the sum would be
 As many as the sheep you see.

Quest. 22. by Mr. Amos Fish.

From Biscay we sail'd with a very fair gale,
 Our course was full north, and we spread ev'ry sail;
 For the weather was curious, unclouded the sun,
 And for several days we with pleasure did run.
 But the wind coming cross, we concluded it best
 To alter our course; so we steer'd full west,
 Till our diff'rence o' longitude was one degree more
 Than the latitude's diff'rence we had sail'd before.

Now, pray sir, resolve me how far we have run,
 And how far 'tis from Biscay from whence we begun.
 All the help I can give you tow'rds finding it out,
 Is, that the nearest distance when we tack't about,

To

To a streight line, if drawn from the place where we be
 To Biscay, (accounting 60 miles a degree)
 Is sev'n score and ten miles, as sure as can be.

*The Prize Question for 1711, that whoever first answers
 shall have a dozen dairies.*

When tir'd with bus'ness, or perplex'd with care,
 Or minded am to breathe in fragrant air,
 I to my lonesome garden strait retire,
 To soothe those cares, and nature's works admire.

Here rows of charming greens delight the eye,
 And here a chrystal stream glides gently by:
 There lovely flow'rs adorn their earthy bed,
 Blended with curious dyes of white and red:
 But when one lovelier than the rest I find,
 It brings the charming sex into my mind.

For of all beauties in the world we know,
 A beauteous woman does the rest out-do.

Within this place I have two lofty firs,
 Which above all my trees my mind prefers.
 Upright, and streight, and taper to the top,
 On each of which a gilded ball I've put.
 Between each tree, when measur'd on the ground,
 In a streight line, just six-score feet I've found.
 The higher tree one hundred feet contain,
 Four-score the lower (both stand on a plain.)
 Between my trees a fountain I would place,
 (The better still my garden for to grace)
 But so, that from the ball o'th' top each tree
 Should to my fount of equal distance be.

And from this fount a walk I would have made,
 And with such nicety of art be laid,
 That as along the same I near or far do move,
 I'd equal distant be from each o'th' balls above.

At this walk's end a house of pleasure I
 Would have so plac'd by art, that when I lie
 Upon my couch, to meditate, or read,
 Or sometimes sleep to ease my aking head,
 From ball to ball, and from each ball to me,
 May equal distance from each other be.

Come, artists, now revolve within your mind
 How these things must be done; and then to find.
 How far my house of pleasure plac'd must be
 From th' fount, and from the bottom of each tree?

This question, and quest. 17. of the tinker, &c. of this
 diary: also the questions last year of the *Lady's Age*, and
 of *Bow Steeple*, are good patterns how an arithmetical ques-
 tion

tion should be compos'd: namely, to cloathe it with such delightful circumstances, as should egg us on to the solving the most useful part. To heighten delight, whet the imagination, and sharpen invention all at once, to enlarge the capacity of the mind, and raise our pleasure to the highest pitch it is capable of; and I hope the poetical artist will in time to come send me some such questions as these.

1712.

Answers to the Geographical Paradoxes propounded in the last year's diary.

Paradox 1, answered by Mr. Hutchinson.

Between the tropicks and the line,
That female I can shew,
That twice the sun on the same point,
I'th' morn, and ev'n, may view.
And tho' our english ladies charms
Excel her far by day,
In silent Nox's soft embrace
She's no less charms than they.

** Paradox 2, explained by Mr. Nat. Brown.*

That famous mountain Teneriff you call,
Whose towring pike o'er-looks this earthly ball,
Four miles and quarter is, and something higher;
A height prodigious that all men admire. (4²⁸¹)

Solutions.

* The solution of this paradox is only an easy example in plane trigonometry, in which the radius of the earth is one leg of a right-angled triangle, the sum of the said radius and height of the mountain is the hypotenuse, and the angle included by them is equal to the degrees in the arc of the visible distance. Now taking the refraction 35' from 3° 30' leaves 2° 55' for the said angle, and $21600 \div 2 \times 3'14159 \&c. = 3437'747$ is the earth's radius in geographical miles; then as the cof. of 2° 55' : rad. or sine of 90° :: 3437'747 : 3442'206; from which taking 3437'747, we obtain 4'459, miles for the mountain's height; which is a little different from the answer above given.

Solutions to the last year's Questions.

I. Question 17, answered by Mr. Rich. Parker.*

Before the last christmas there came to my house,
 A jolly fine tinker, who seem'd very chouse;
 I askt him, If store of good work he had got:
 He reply'd, that he had; but that he like a sot,
 Undertook t'other day for a critical asf,
 "To make him a flat-bottom'd kettle of brafs,
 "Whose widenefs at top and at bottom should be
 "In the same proportion as five is to three,
 "The depth it should justly twelve inches contain,
 "And that it should hold in ale gallons thirteen.
 That he try'd many ways for to bring it about,
 And yet after all he could make nothing out:
 Which at length it had made him so wondrous poor,
 That work for a tinker he crys at each door;
 Who had brafs, and had money enough just before.

The tinker's sad story did make my heart ake,
 So I gave him the measure each widenefs would take,
 (As hereunder you'll find) for his kettle to make.

With a great deal of joy then away went my friend,
 Crying, Have ye any work for a tinker to mend?
 Any boles, any bellows, any pots made of mettle;
 But he ne'er could endure for to hear of a kettle.

Lesser diameter 14'6390238.

Greater diameter 24'398373.

The ingenious Mrs. *Barbara Sidway*, in answer to this question, proposeth another very pretty one at the same time.

Well, bonny brave tinker, to save thee from ruin,
 The kind british lassies are active and doing;
 Because that thou art a brave fellow of mettle,
 Take here the diameters both of thy kettle;
 One's twenty-four inches, four-tenths, very near,
 T'other fourteen, and sixty-four cents doth appear.

Question

* I. QUESTION 17. solved.

Putting 5z and 3z for the top and bottom diameters, by page 525 Mensuration, we shall have $(3 \times 64zz + 4zz)$ or 196zz
 $\times 12 \times .00023109 = 13$: hence $z = \sqrt{\frac{13}{196 \times 12 \times .00023109}}$
 $= 4.880057$; consequently $3z = 14.640171$, and $5z = 24.400285$,
 the two diameters required.

* *Question to the tinker, or his friend.*

But now if it was to hold as much again,
And carefully lengthened at its biggest end,
(The whole being a frustum cone) I would fain know
How much is the depth of that added below?

† II. *Question 18. answered.*

The first of your numbers, without any blunders

I find to be one that is mixt,

Fifteen the whole part, according to art,

And just fifty one—fifty sixths. ($15\frac{1}{6}$)

Then, dear madam Fisher, for I do not miss here,

Denominate seven times eight; ($\frac{3}{8}$)

Thrice eleven of these, you may take if you please,

So your question is answer'd compleat.

Question

* *Answer to the question to the tinker, or his friend.*

If $5a$ and $3a$ be the diameters of the first or given frustum, whose altitude is 12, and z the altitude of the frustum to be added: Then, by similar triangles, &c. $\frac{1}{6}z + 5a =$ the greater diameter of the part added; and since the two contents are equal, we shall

have $\frac{1}{6}az + 5a^2 + \frac{1}{6}az + 5a \times 5a + 25a^2 \times z =$
 $25aa + 15aa + 9aa \times 12$, or $\frac{1}{6}z + 5^2 + \frac{1}{6}z + 5 \times 5 + 25 \times z$
 $= 49 \times 12 = 588$, or $z^3 + 90z^2 + 2700z = 21168$. Hence
 $z = 6.3847619 =$ the height of the part to be added.

† II. *QUESTION 18. solved.*

Put z for the less number: then, by the question, either $16\frac{1}{2} - z$ or $27z$ will express the greater: hence $27z = 16\frac{1}{2} - z$, or $28z = \frac{33}{2}$; then $z = \frac{33}{56} =$ the less number, and consequently $16\frac{1}{2} - \frac{33}{56} = 15\frac{1}{6} =$ the greater.

O T H E R W I S E.

Let $x =$ the less number; then $27x =$ the greater, and $28x = 16\frac{1}{2} = \frac{33}{2}$; hence the rest will be as above.

O T H E R W I S E.

Since, as above, the numbers are in proportion as 27 to 1, and their sum $= 16\frac{1}{2}$: hence as $28 : 16\frac{1}{2} ::$ $\begin{cases} 1 : \frac{33}{56} = \text{the less number.} \\ 27 : 15\frac{1}{6} = \text{the greater.} \end{cases}$

* III. *Question 19, answered by J. R. S.*

These fractions I have set down below,
The answer to your nineteenth question show.

$$\frac{1}{11} \qquad \frac{4}{77}$$

† IV. *Question 20, answered by Mrs. Sidway.*

Great heroes deeds no poets lines express,
Nor worthy actions recompens'd in verse;
Numbers alone their merits must recount,
See here below how vast the sums amount.

$$\frac{91}{1} \times \frac{92}{2} \times \frac{93}{3} \times \frac{94}{4} \times \frac{95}{5} \times \frac{96}{6} \times \frac{97}{7} \times \frac{98}{8} \times \frac{99}{9} \times \frac{100}{10} = 17310309456440 \text{ farth.} = 18031572350 \text{ l. } 9 \text{ s. } 2 \text{ d.}$$

V. *Quest. 21, answered by Mr. Alexander Weedon.*

Oh happy man! what charms did you invite,
When such a knot of fair ones came in sight;
It must enlarge and elevate your soul,
And make it boundless too without controul.
To see their lovely looks, their charming mein,
Their modest blushes, as they grac'd the green;
Their shape so ravishing, that Cupid's dart
You needs must feel quite through and through your heart,
When

* III. *QUESTION 19. solved.*

Let $\frac{1}{14} + z$ and $\frac{1}{14} - z$ express the two numbers; then

$$\frac{1}{14} + z \times \frac{1}{14} - z = \frac{1}{196} - zz = \frac{4}{847}; \text{ hence } z = \sqrt{\frac{1}{196} - \frac{4}{847}} = \frac{3}{154}; \text{ consequently } \frac{1}{14} + \frac{3}{154} = \frac{1}{11} = \text{the greater number, and } \frac{1}{14} - \frac{3}{154} = \frac{4}{77} = \text{the less number.}$$

† IV. *QUESTION 20. solved.*

The number of variations of 10 in 100 are $\frac{100}{10} \times \frac{99}{9} \times \frac{98}{8} \times \frac{97}{7} \times \frac{96}{6} \times \frac{95}{5} \times \frac{94}{4} \times \frac{93}{3} \times \frac{92}{2} \times \frac{91}{1} = 17310309456440 =$
the number of farthings $= 18031572350 \text{ l. } 9 \text{ s. } 2 \text{ d.} =$ the sum demanded.

When eight fair shepherdesses to your view, (8 maids)
 Were altogether met beholding you.
 Who came to feed their harmless flocks of sheep,
 Which daily they did on the common keep;
 The number just one hundred twenty eight, (128 sheep)
 On which they did so diligently wait.
 Which numbers both do very well agree:
 The question's solv'd as plainly you may see.*

Mrs. Barbara Sidway, to Mr. Gideon Crofier, the proposer.

The sheep were one hundred twenty eight,
 The virgins, twice four, and a glorious sight.
 But honest master *Gideon Crofier*,
 Upon my word you sent a poser:
 Had not the number easy been, Sir,
 You might have whistled for an answer.
 For do but in your mind revolve,
 Questions such as this to solve,
 This same equation must reduce,
 As underneath you may peruse,
 Where (a) the vowel, is unknown, Sir,
 Reduce it, and call me your own, Sir.

$$r^a = rdaa. \text{ Or, } r^{a-1} = daa.$$

VI. *Question 22, answered by the same.*

Sail'd north	_____	188° 256 miles
Sail'd west	_____	248° 256
Distance run	_____	436° 512
From Biscay to the ship's place	_____	311° 555

Suppose

* V. QUESTION 21. *solved.*

If z be put to denote the number of maids; then, by the question, $z \times 2z = 2zz$ will denote the number of the sheep, and $2zz = 2^{z-1}$; hence, multiplying by 2, we have $4zz = 2^z$; and, by extracting the root, $2z = 2^{\frac{1}{2}z}$: From this equation, by trials, we easily find $z = 8 =$ the number of maids; and then $2zz = 128$ the number of sheep.

When the quantity of z is an integer number, it is best found by trials as above. But if it be some infinite decimal, put the above equation into logarithms, and we have $\frac{1}{2}z \times \log. 2 = \log. 2 + \log. z$, or $\cdot 150515z - Z = \cdot 301030$, putting $Z = \log. \text{ of } z$; then find the value of z by double position or the method of trial-and-error.

Mathem.

H

Suppose it plain failing, the answer you see,
 But if by Mercator, pray, what would it be?
 That handsome tarpawlin I almost durst wed,
 That has the true method thereof in his head.*

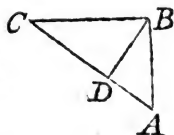
Answer to the Prize Question, which was first answered by Mr. Henry Beighton, and soon after by Mrs. Anna Wright, Mr. Ford, Salt-officer of Middlewich, and divers others.

I lately heard your curious garden nam'd,
 For its exactness all o'er England fam'd:

Your

* VI. QUESTION 22. solved.

From the right angle B let fall the perpendicular BD : If AB represent the distance sailed north, and BC the distance west; then will AC represent the distance between *Biscay* and the place arrived at, and BD 150 miles.



Now by right-angled triangles we have

$$AC^2 = CB^2 + BA^2,$$

$$\text{and } 2 AC \times BD = 2 CB \times BA;$$

hence, subtracting the second equation from the first, we have
 $AC^2 - 2 AC \times BD = CB^2 - 2 CB \times BA + AB^2 =$
 $(CB - BA)^2$, and $AC = BD + \sqrt{BD^2 + CB - BA^2} =$
 $150 + \sqrt{150^2 + 60^2} = 150 + 30\sqrt{29} = 311.554944214 =$
 the distance from *Biscay*.

And, by adding the second equation to the first, we have
 $AC^2 + 2 AC \times BD = CB^2 + 2 CB \times BA + AB^2 =$
 $(CB + BA)^2$, and $CB + BA = \sqrt{AC^2 + 2 BD \times AC} =$
 $\sqrt{611.5549 \&c \times 311.5549 \&c} = 436.50082 =$ the whole distance run.

Also, by adding and subtracting the difference and sum, we have CB and $BA = \frac{436.50082 \pm 60}{2} = 248.25041$ and 188.25041 .

The CONSTRUCTION is evident from the above process, viz.

Make $AC = (BD + \sqrt{BD^2 + CB - BA^2})$ the sum of BD and the hypotenuse of a right-angled triangle whose two legs are BD and $CB - BA$: then the sum of the legs $(CB + BA)$ being equal to $(\sqrt{AC + 2 BD \times AC})$ the mean proportional between AC and $AC + 2 BD$, the legs CB , BA themselves will be the half sum and difference of $CB - BA$ and the said mean proportional.

Your lofty firs, so streight, so smooth, so tall,
 Each of them crowned with a golden ball:
 One eighty foot, yet twenty foot out-done,
 By his tall fellow, trowing tow'rs the sun.
 Between your trees is plac'd a fountain clear,
 Nearer which ball, no mortal can declare,
 A pleasure house is plac'd with such nice art,
 That with the balls three equal lengths impart.
 And if from thence you walk to th' fountaina clear,
 You to each ball at equal distance are:
 The distance then betwixt each ball in measure,
 Also betwixt each ball and th' house of pleasure,
 Likewise from th' house and bottom of each firr,
 And from the house unto the fountain clear,
 And from the fount to th' bottom of each tree,
 The lines below, I hope, will let you see.

From ball to ball	—	—	121 65525
From each ball to the pleasure house	121	65525	
From the lower tree bottom to the house	91	65151	
From the taller tree bottom to the house	69	28203	
From the house to the fountain	—	52 67827	
From the lower tree bottom to the fount	75		
* From the higher tree bottom to the fount	45		

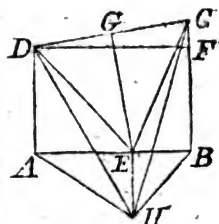
The

* THE PRIZE QUESTION.

Let AD be the one tree, and BC the other. Draw CD the distance of the two balls. On the middle of which and perpendicular to it draw GE , and E will be the fountain. For then DE will be $= EC$ by *Eucl. I. 4*.

Also the required path, at the end of which stands the pleasure house, will be a right line EH perpendicular to AB , and $=$ one leg of a right-angled triangle whose other leg is EA , and its hypotenuse $AH =$ the base of another right-angled triangle ADH whose perpendicular is AD and hypotenuse $DH = DC$.—For, because of the path's continual equal distances from the balls, it will be the intersection of the horizontal plane and another plane perpendicular both to the line DC and the vertical plane $ABCD$, and this intersection is perpendicular to AB by *Eucl. XI. 19*.

The CALCULATION. Since $(ED^2 =) DA^2 + AE^2 = (EC^2 =) CB^2 + BE^2$; therefore, by equal subtraction, $BC^2 - DA^2 = AE^2 - EB^2 = AB \times AE - EB$; and
 H 2 hence



The same answered by Mr. Edward Walker.

In your fair garden garnished with flowers,
 Circled with chryſtal ſtreams, and charming bowers,
 Your pleaſure houſe from the clear fount muſt ſtand
 Fifty two feet, with ſome odd parts behind,
 And from the bottom of the greateſt tree,
 Sixty nine, more by an half muſt be;
 And for the reſt, you here above may ſee.

The eclipses of this year 1712.

There will be four eclipses this year. The first is a small but viſible eclipse of the moon, on january the 12th; it begins at 1 minute after 7 at night, the middle is at 52 minutes after 7, the end at 43 minutes after 8; the whole duration is 1 hour and 42 minutes, and will be about two digits and an half eclipsed on the north ſide.* The ſecond eclipse is of the ſun, on the 22d of june, at 10 at night, and therefore cannot be ſeen. The third is of the moon, the 8th of july, at 8 in the morning,

$$\text{hence } AE - EB = \frac{BC^2 - DA^2}{AB} = \frac{100^2 - 80^2}{120} = 30 :$$

$$\text{Conſequently } AE \text{ and } EB = \frac{AB \pm 30}{2} = \frac{120 \pm 30}{2} = 75$$

and 45, the diſtances of the fountain from the bottoms of the two trees. And $DE = EC = \sqrt{CB^2 + BE^2} = \sqrt{100^2 + 45^2} = 5\sqrt{481} = 109.65856099$ the diſtance of each ball from the fountain. Alſo $DH = HC = CD = \sqrt{DF^2 + FC^2} = \sqrt{120^2 + 20^2} = 20\sqrt{37} = 121.6552506$. Hence $BH = \sqrt{HC^2 - CB^2} = \sqrt{20^2 \times 37 - 100^2} = 20\sqrt{12} = 69.2820323$ = the diſtance of the pleaſure houſe from the foot of the taller tree. $AH = \sqrt{HD^2 - DA^2} = \sqrt{20^2 \times 37 - 80^2} = 20\sqrt{21} = 91.651513899$ = the diſtance of the ſame from the lower tree. And $EH = \sqrt{HB^2 - BE^2} = \sqrt{20^2 \times 12 - 45^2} = 5\sqrt{111} = 52.67826876$ = the length of the walk, or the diſtance of the pleaſure houſe from the fountain.

* This eclipse [January 12] was obſerved as follows :

I. At Greenwich by Mr. Flamſteed.

He ſays the middle of the eclipse was at 7 h. 40 m. 50 s. by the clock, or 7 h. 34 m. correct time. At which time the chord of the eclipsed part of the moon was 24. 30 : but the greateſt defect on the northern ſide was 8. 30. The moon's diameter 30. 48.

II. At

morning, and therefore invisible. The fourth is of the sun, on the 17th of december, at 1 in the morning, and therefore can't be seen.

New Arithmetical Questions.

L. Question 23. *The widow's case, by Mr. Lewis Even-*

Ingenious ladies, whom their stars benign
Render'd their fates more happy far than mine:
Assist, I pray, so may you never see
Such dismal days as heav'n allotted me.
My second-self, the one half of my life,
Whom to survive yields me the greatest grief,
The fates unkind has snatch'd away in's prime,
I for this loss shed tears more salt than brine;
Depriv'd of all my joys and hopes at once,
The greatest that all love could e'er advance;

I be'ng

II. At *Upminster* by Mr. *W. Derham*.

h. m.

- 6 15 A duskiſhneſs upon the N. E. ſide of the moon.
6 36 A thick penumbra on the moon.
6 37 The penumbra ſo denſe that it may be taken for the be-
ginning of the eclipse.
6 39 The eclipse undoubtedly is begun.
8 31 End of the eclipse is very near.
8 32 End of the eclipse.
8 32 $\frac{3}{4}$ Eclipse is undoubtedly ended.
8 36 A penumbra is left.

III. At *Uratistavia* (*Breslaw*) by *R. P. Christopher Heinrich*.

h. m. s.

- 7 15 39 A duskiness observed on the moon.
7 34 54 Beginning of the penumbra.
7 40 11 Beginning of thick darkness.
7 56 3 *Aldebaran* culminated.
8 38 7 *Orion's* western foot culminated.
9 11 18 *Orion's* eastern foot culminated.
9 38 33 End of the thick shadow.
9 44 4 End of the penumbra.
10 9 17 *Sirius* culminated.

The solar time was measured by a pendulum clock; and corrected by the observed culminations of four fixed stars. And the quantities were determined by a micrometer in the telescope.

The shadow through the telescope seemed ash-coloured, bluish and approaching to blackness. It began to appear above *Aristarebus*, and then passed over the upper part of the moon.

Н. 3.

I be'ng with child the time my dear lay ill,
 He this provision made by his last will.
 T' th' child i' th' womb, if male, two parts in three
 Of this his wealth he gave; one third to me.
 But if by me the pow'rs above are pleas'd
 The number of the fair should be increas'd,
 Then I was to enjoy two parts in three;
 One third should to my fair a fortune be.
 My dearest dies: e're long was God's decree
 Made known, how he was pleas'd to deal with me:
 His blessed pleasure was, that at one birth
 I both a son and daughter should bring forth.
 This double birth, unthought of by my dear,
 Makes th' execution of the will appear
 Ambiguous unto me, and therefore I
 Must needs my self to better heads apply.
 Sev'n thousand pounds my dear's estate is priz'd,
 In this odd case, I crave to be advis'd,
 This to divide according to the will
 Betwixt us three: I pray exert your skill.
 What ever priviledge the widows have
 By force of law, most willingly I wave:
 To lawyer for advice I'll give no fee,
 My husband's will a law shall be to me.

II. *Question 24, by Mr. Amos Fish.*

I have holland, and muslin, and scotch cloth good store,
 I have cambrick, you never saw better before:
 The number of ells of each sort I can't tell,
 But the whole sum together, I remember right well,
 Was just thirty thousand; nay, more I can show,
 The first and the last I very well know,
 Be'ng multiply'd together proved to be the same sum,
 To which the product of muslin and scotch cloth did come,
 And the squares of the holland and cambrick when join'd,
 In one sum, will be one hundred sixty millions you'll find.
 But the number of ells that each sort did contain,
 I would willingly know, but I labour in vain,
 And if you don't help, I'm afraid of my brain. }
 One thing I forgot, which is proper to tell,
 The holland was most by many fair ell.

III. *Question 25, by Mr. Alexander Weeden.*

If a square piece of timber be
 Exactly twelve foot long;
 Three inch the side o' th' less square base,
 The greater, twenty one:

Then

Then this I very fain would know,
How many feet in all;
And what's each solid foot's true length,
From greater base to th' small?

IV. *Question 26, by Mr. John Burnet.*

Suppose, fir, a bushel be exactly round,
Whose depth be'ng measur'd eight inches is found;
If the breadth eighteen inches and an half you discover,
This bushel is legal all England over.
But a workman would make one of another frame,
Sev'n inch and an half must be th' depth of the same:
Now, fir, of what length must th' diameter be,
That it may with the former in measure agree.

V. *Question 27, by Mr. John Wilson.*

If to my months you should add half their sum,
And one eighth more, and then should subtract one;
The residue would such a number be,
As twenty one being squar'd, assuredly.

VI. *Question 28, by Mr. Henry Beighton.*

I hired a horse, for to visit my dear,
(A lovely sweet maid of complexion most clear:)
At three pence a mile, for the hire we agreed;
So from London to Bristol I rid with full speed,
Being miles ninety four, and it lyeth full west:
But when I came there my dear virgin I mist.
For sometime before she was gone to West Chester,
With a man, as they told me, she hugg'd and kist, fir:
Nay, so fond she was of him, she li't him to bed,
And for several hours there with him she staid.
This made me distracted; so away I set forth
To Chester, which lieth from Bristol full north.
I whipped and spur'd, and I scoured away,
And woman! false woman! was all I could say.
But the number of miles I did ride, I can't tell,
My heart did with envy and passion so swell.

When I came to West Chester, I found to my joy,
That it was her own father had took her away.
I streight made proposals to marry his daughter,
But he said he'd take time for to think on the matter.
From Chester to London we directed our aim,
And at sixty six miles we to Coventry came:
Where I press'd things so home, that we made up the match,
But to Bristol I must first some writings go fetch.

(The

(The road's perpendicular to that we last came)
 And they promis'd to stay till I came back again.
 A young eager lover, you need not bid haste,
 When the nuptial joys he is ready to taste.
 Upon my return, we to London did go,
 But the joy of our marriage transported me so,
 That I never enquired the miles I did go.
 Now the man for the hire of his horse he has sent,
 And willing I am for to give him content:
 But how much is due, neither him nor I know,
 No more than the horse that I rode on, I vow.
 Pray, sir, be so kind as to tell me the sum,
 And a bottle I'll give you when that way I come.

The Prize Question, (of ten Diaries by lot) proposed by Mr. Peter Hingston, jun. (a scholar in Ipswich grammar school.)

Of the regular bodies platonick, you know,
 The dodecaedron twelve faces does show,
 That are bases of pentangled pyramids join'd,
 By their tops at the centre. Now, sir, I pray mind:
 If, as large as each pyramid's bulk will admit,
 All the bases be dug into concaves, to wit,
 Into hemispheres, cylinders, cubes-too and cones,
 Into pyramids likewise; triangular ones,
 And quadrangular also; of each of these two;
 (In each side one of them;) sir, can you this do?
 If the matter 'tis made of does weigh, being try'd,
 For each solid foot sixty pounds, and the side
 Of each pentangle eight inches be, and no more,
 By geometry, what it weighs justly explore.

1713.

Solutions to the last year's Questions.

I. Question 23, answered by Mrs. Anna Wright.

WHEN first the widow's mournful case I read,
 My sympathizing heart with grief did bleed;
 Her I'll assist, said I, her doubts resolve;
 Then in my mind I did the case revolve:
 Where soon the widow's share by will I found.
 To be no less than just two thousand pound;
 One thousand pounds left to her daughter dear,
 And just four thousand to her son and heir.

I had

I had a great many excellent answers to this question by Mr. Moyle, Mr. John Wilson, Mr. Newbold, Francius, Mr. Abel Ragg, and others; but having so little room to spare, my fair reader, I hope, will pardon me if I insert but one more solution of this question, and one only of each of the ensuing.

** The same Question answered by Mr. James Cole.*

Dispel those clouds which hover o'er your head,
 Since that your love, your dearest love is dead;
 To weep, and mourn, alafs 'tis all in vain!
 For you can never bring him back again!
 If whilst on earth, he walk'd in vertue's ways,
 He now with joy sings his redeemer's praise;
 Which joy shall last beyond the reach or power
 Of time, with's teeth of iron, to devour.
 With winged speed he's gone from cares below,
 T' a place which mortals are too frail to know.
 Therefore with comforts calm your troubl'd mind,
 To think your husband left those cares behind.
 As for the execution of his will,
 And how the same you rightly may fulfil,
 Look underneath, and there you'll plainly see,
 The manner how th' estate must parted be.
 (*Here followed the answer, being the same as above.*)

II. Question 24, by Mr. John Newbold.

Good Mr. Fisher, I am your well wisher,
 If draper or scotchman you be;
 And have sent you the answer, as plain as I can, sir,
 Tho' unskill'd in the commodity.
 In th' holland I'm right, and the cambrick white,
 But the other are dubious, whether
 Are the greater o'th' two, so I leave it to you,
 Till time will permit you to measure.

Twelve

** I. QUESTION 23. solved.*

By the will, the mother's share was to be the double of the daughter's, and the son's the double of the mother's; wherefore they will be in proportion as the numbers 1, 2, and 4; and the sum of these numbers being 7, it appears that the shares will be $\frac{1}{7}$, $\frac{2}{7}$, and $\frac{4}{7}$ of the whole estate: viz.

$\frac{1}{7}$ of 7000*l.* = 1000*l.* = the daughter's share.

$\frac{2}{7}$ of 7000*l.* = 2000*l.* = the mother's share.

$\frac{4}{7}$ of 7000*l.* = 4000*l.* = the son's share.

Twelve thousand the first, four thousand the last,

The other two are * eight and * six; (* i.e. 8000 & 6000)

But the number to each are out of my reach,

There's no certainty what to affix.†

Holland 12000, muslin 8000, scotch cloth 6000, and cambrick 4000.

† III. *Question 25, answered by Francius.*

The feet the timber does contain, below you plain may find:
Likewise each foot's true length is shewn, according to your (mind).

The first solid foot's length is 4'0136, the second is 4'2208, the 3d is 4'4552, the 4th is 4'7272, the 5th is 5'0448, the 6th is 5'42, the 7th is 5'876, the 8th is 6'4408, the 9th is 7'1656, the 10th is 8'1352, the 11th is 9'5208, the 12th is 11'7096, the 13th is 15'8776, the 14th is 29'4824, and the 25 is 21'9104.

IV. *Quesf.*

† II. *QUESTION 24. solved.*

This question is unlimited, for there are four unknown quantities, and only three conditions. And, to determine the rest, one of them must be assumed.

Put z, y, x, v for the four quantities; then

$$z + y + x + v = 30000 = a,$$

$$zv = yx,$$

$$zz + vv = 160000000 = b.$$

To and from the third adding and subtracting the double of the first, we have $zz \pm 2zv + vv = b \pm 2xy$; hence $z \pm v =$

$\sqrt{b \pm 2xy}$; then by substitut. in the first, we get $y + x + \sqrt{b + 2xy}$

$= a$; from this is obtained $y = a - \sqrt{b + 2ax} - xx$: by assuming $x = 6000$, this expression gives $y = 8000$. And then z

and $v = \frac{\sqrt{b + 2xy} \pm \sqrt{b - 2xy}}{2} = 12000$ and 4000 .

† III. *QUESTION 25. solved.*

By page 159 Mensuration, the solidity of the whole piece will be $\frac{21 \times 21 + 21 \times 3 + 3 \times 3}{3} \times 12 \times 12 = 24624$ inches =

$14\frac{1}{4}$ feet. And if the frustum be supposed to be compleated to a pyramid; then, by similar triangles, as $21 - 3$ is to 21 , or as 18 to 21 , or as 6 to 7 , so is 12 to 14 feet its altitude; and

hence $\frac{21 \times 21}{3} \times 14 \times 12 = 24696$ inches = $14'29\frac{1}{2}$ feet =

the content of the whole pyramid. Whence, as similar solids are as the cubes of their like dimensions, we shall have $\sqrt[3]{14'2916}$:

$\sqrt[3]{13'2916} :: 14$ feet or 168 inches : $168\sqrt[3]{\frac{13'2916}{14'2916}}$ inches, and

168 —

* IV. *Question 26, answered by Mr. Tho. Shephard.*

The diameter's length if the workman would know,
To please his nice fancy unto him pray shew, *(inches)*
The answer that I have here placed below, *(viz.)* 19'1067.
V. *Quef-*

$$168 - 168 \sqrt[3]{\frac{13'2916}{14'2916}} = \frac{\sqrt[3]{14'2916} - \sqrt[3]{13'2916}}{\sqrt[3]{14'2916}} \times 168 =$$

$\sqrt[3]{14'2916} - \sqrt[3]{13'2916} \times 69'228 =$ the altitude of the lowest or 1st foot. And in like manner all the others will be found as below.

$$: \sqrt[3]{14'2916} - \sqrt[3]{13'2916} : \times 69'228 = 4'0134 = \text{alt. of 1st foot}$$

$$: \sqrt[3]{13'2916} - \sqrt[3]{12'2916} : \times 69'228 = 4'2203 = \text{--- 2d}$$

$$: \sqrt[3]{12'2916} - \sqrt[3]{11'2916} : \times 69'228 = 4'4557 = \text{--- 3d}$$

$$: \sqrt[3]{11'2916} - \sqrt[3]{10'2916} : \times 69'228 = 4'7273 = \text{--- 4th}$$

$$: \sqrt[3]{10'2916} - \sqrt[3]{9'2916} : \times 69'228 = 5'0442 = \text{--- 5th}$$

$$: \sqrt[3]{9'2916} - \sqrt[3]{8'2916} : \times 69'228 = 5'4205 = \text{--- 6th}$$

$$: \sqrt[3]{8'2916} - \sqrt[3]{7'2916} : \times 69'228 = 5'8765 = \text{--- 7th}$$

$$: \sqrt[3]{7'2916} - \sqrt[3]{6'2916} : \times 69'228 = 6'4406 = \text{--- 8th}$$

$$: \sqrt[3]{6'2916} - \sqrt[3]{5'2916} : \times 69'228 = 7'1649 = \text{--- 9th}$$

$$: \sqrt[3]{5'2916} - \sqrt[3]{4'2916} : \times 69'228 = 8'2354 = \text{--- 10th}$$

$$: \sqrt[3]{4'2916} - \sqrt[3]{3'2916} : \times 69'228 = 9'5210 = \text{--- 11th}$$

$$: \sqrt[3]{3'2916} - \sqrt[3]{2'2916} : \times 69'228 = 11'7093 = \text{--- 12th}$$

$$: \sqrt[3]{2'2916} - \sqrt[3]{1'2916} : \times 69'228 = 15'8778 = \text{--- 13th}$$

$$: \sqrt[3]{1'2916} - \sqrt[3]{0.2916} : \times 69'228 = 29'4827 = \text{--- 14th}$$

the sum 122'0896 being taken from
12 feet or 144'0000 inches, we have

$$21'9104 = \text{alt. of the } \frac{1}{4} \text{ f.}$$

* IV. *QUESTION 26. solved.*

Since equal cylinders have their altitudes reciprocally proportional to the squares of their diameters, we shall have, As $\sqrt{7\frac{1}{2}} :$
 $\sqrt{8} :: 18\frac{1}{2} : 18\frac{1}{2} \sqrt{\frac{8}{7\frac{1}{2}}} = 18\frac{1}{2} \sqrt{\frac{16}{15}} = \frac{74\sqrt{15}}{15} = 19'10671784$
inches = the diameter required.

Answer to the Tinker's Question, by Mr. Richard Parker.

If the top of the kettle be lengthened on,
(With a figure that's just like a frustum cone,)
Six inches and thirty nine cents, and no more,
Will make it to hold twice as much as before.

** Answer to the Prize Question.*

Tho' I received seven answers to this question, only three of them were right, (*viz.*) Mrs. *Barbara Sidway*, Mr. *Beighton*, and one more (who desired to conceal her name.) Mrs. *Sidway's* answer was very fine, and in good verse, but so very long, I have not room to insert it: I shall therefore only set down the answer.

The dodecaedron weighs, after all the twelve cavities are cut out, 60'6527 pounds.

The

** PRIZE QUESTION solved.*

Let *ABEFGH* be one of the twelve pyramids constituting the dodecaedron, and *C* the center of its base: draw *CD* perpendicular to *BE*, and the rest of the lines as in the figure.

Putting $A = 8 = BE$ one side of the pentagon or base, by page 410 Mensuration, we have $AC = A \sqrt{\frac{25 + 11\sqrt{5}}{40}}$

$= 1.113516 A$; and $CD = \frac{1}{2} A \times \text{tang. } 54^\circ = .68819095 A = \text{radius of the base of the cone. And, since the greatest inscribed cylinder is known to be } \frac{4}{9} \text{ of the cone, we shall have } \frac{1}{9} CD^2 \times 3.14159 \text{ \&c.}$

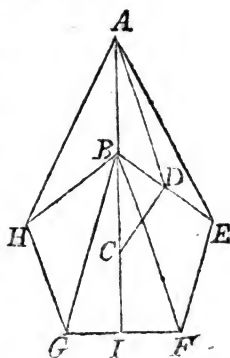
$\times \frac{1}{7} CA = 2.14916 A^2 \times \frac{1}{7} CA = \text{the the cone and cylinder together.}—\text{But}$

the greatest triangle in the pentagon is *BFG*, and the greatest quadrangle is *BFGH*; the sum of these two is the $\triangle GHB + 2 \triangle BFG$. Now the $\triangle GHB = GH \times HB \times \frac{1}{2} s. \angle H = \frac{1}{2} A^2 \times s. 108^\circ = .47552825 A^2$, and $2 \triangle BFG = BI \times GF = A^2 \times \frac{1}{2} \text{ tang. } \angle BFI = A^2 \times \frac{1}{2} \text{ tang. } 72^\circ = 1.53884175 A^2$; the sum of these two is $2.01437 A^2 = \text{the bases of the triangular and quadrangular pyramids together; and consequently their contents together will be } 2.01437 A^2 \times \frac{1}{3} AC. — \text{Adding this to the sum of the cone and cylinder above found, we have } 4.16353 A^2 \times \frac{1}{3} AC = 1.545386 A^3 = \text{the sum of these four solids.}$

Mathem.

I

Again,



The Eclipses of this Year.

Of four eclipses which will happen this year, only one of them will be visible. The first is an eclipse of the moon, may 28, near half an hour after 6 in the afternoon, and therefore invisible. The second is an eclipse of the sun, on the 11th of june, half an hour before midnight, and therefore invisible to us, but will be visible to our antipodes. The third is a visible eclipse of the moon on november 21. The beginning will be at Coventry 8 min. after 2 in the morning; the middle at 18 min. after 3; and the end at 23 min. after 4 in the morning. The whole duration is 2 ho. 18 min. The digits eclipsed are 5 deg. very near. Lat. of the moon in the beginning

$$\text{Again, } DA = \sqrt{AC^2 + CD^2} = \frac{3 + \sqrt{5}}{4} A = 1.309017 A,$$

$$\text{and by similar triangles } AD : DC :: CA : \frac{AC \times CD}{DA} = \frac{5 + 3\sqrt{5}}{20} A = .5854102 A = \text{the radius of the inscribed he-}$$

misphere; and consequently its solidity is $.5854102 A^3 \times \frac{2}{3} \times 3.14159 \&c. = .4201837 A^3$.

Also, a square may be inscribed in a pentagon by placing one of its sides parallel to a side of the pentagon; and, by calculation, it appears that, if z be the side of the square, $z \div 1.0604974$ will be the side of the pentagon; hence, if this square be one face of the cube, and the pentagon the section of the pentagonal pyramid parallel to the base and distant from it the height of the cube, we shall have, by similar figures, $AC : BE :: AC - z : z \div 1.0604974$; hence $z = \frac{1.0604974 AC}{1.0604974 A + AC} \times A = .5431802 A$ = the side of the cube: And consequently the cube of this, or $.1602616 A^3$ = the content of it.

Collecting now these three sums together, and multiplying by 2, we have $4.2516646 A^3$ for the contents of the twelve cavities.

$$\text{But, by p. 408 Mensuration, } 5 A^3 \sqrt{\frac{47 + 21\sqrt{5}}{40}} = 7.6631189 A^3 = \text{the content of the dodecaedron.}$$

Consequently the difference of these two = $3.4114543 A^3 = 1746.6646016$ inches = 1.0108013 feet = solidity remaining; which at 60 lb. a foot, weighs 60.648077 lb.

N. B. *False numbers (but no methods of solution) are given to this question in The Diarian Repository.*

A false solution is also given to question 25 in that book, dissimilar solids being used as familiar ones.

Other mistakes are remarked on the covers of this number.

beginning is 45 min. 42 sec. and at the end 39 min. 12 sec. north descending, the lower or south limb of the moon being darkened. The fourth eclipse is of the sun, on the 6th of december, 4 ho. 22 m. p. m. but invisible to us, the sun being below the western horizon.*

New Questions.

I. Question 29, proposed by Mrs. Sarah Brown.

I ask'd my love when she would wed?
 She cry'd she was too young;
 And that she would still some years stay:
 I asked her, how long?
 Until my years being multiply'd
 By't self, and when you find
 ('Bating one-ninth, adding one-third)
 Nine hundred lacking nine:
 I pray you, ladies, help me find
 What age she'll be when we are joyn'd.

II. Ques-

* *The 3d Eclipse or that for November 21.*

This eclipse was observed as follows :

I. *At Rome by Mr. F. Bianchini.*

Time
 afternoon
 h. m. s.

- 12 53 34 A star in Taurus, by Bayer marked τ , nearly applied itself to the moon's limb; observed by a telescope of 12 palms.
- 12 54 34 It was now hid by that part of the moon's limb, which is almost in the middle between the spots of Aristarchus and Galileus.
- 14 0 14 Sirius came to the meridian, by which the times were verified.
- 15 0 • The penumbra in the limb of the moon, which before was pretty dilute, is now become sensibly denser.
- 15 4 20 The beginning of the incidence of the moon into the true shadow, on that part of the limb which is next to the spot Schickard.
- 17 27 45 The true shadow comes out of the limb of the moon, in a place marked out by drawing a diameter between Aristarchus and Plato.

II. *At the town of S. Joseph, which is 3 h. 52 m. 30 s. difference of meridian from R. Obs. Par. By F. Bon. Suarez.*

10 33 31 Beginning
 12 56 57 End

The greatest quantity obscured was dig. 5 at about 11 h. 45 m.

II. *Question 30, by A. W.*

At London one morning the sun shining plain,
The shadow I found the just length of my cane,
As I held it upright; 'twas the tenth day of May:
Now tell me exactly the time of the day?

III. *Question 31, by Mr. Rob. Wilson.*

A castle wall there was, whose height was found
To be an hundred feet from top to th' ground:
Against the wall a ladder stood upright,
Of the same length the castle was in height.
A waggish fellow did the ladder slide
(The bottom of it) ten feet from the side.
Now I would know how far the top did fall,
By pulling out the ladder from the wall.

IV. *Question 32, by Mr. Lover.*

Three farmers did meet, as they rode on their way,
The first to the other two farmers did say,
If you give me two-thirds of each of your coin,
Then eighty six nobles will be equal to mine.
Nay, friend, says the second, if I should receive
Three-fifths of both yours, the same sum I shall have:
But if from the two first, five-eighths the third take,
Then his the same eighty six nobles will make:
Inform me what each of them had at the first,
Likewise in exchanging what each man disburs'd.

V. *Question 33, by Mr. Peter Walter.*

A noble lady of as noble parts,
Whose wit and beauty crown'd her queen of hearts:
Her noble works the learned world amaz'd,
As did the castles in the air she rais'd.

In one of these a certain night she laid,
Nor did the castle's height make her afraid,
Tho' in the air sev'n measur'd miles 'twas rais'd.

On the next morn betimes she did conspire
By art to raise her seat a story higher:
A fancy then had just receiv'd its birth,
When fell her standish down from thence to earth;
At the same instant, she a sound did hear,
Which came from earth, and pierc'd her tender ear:
Well done, (said she) I'll of my self demand,
(For why my fancy ne'er was at a stand)
How long my standish was in falling thither;
How long the sound was mounting till 't came hither.

Come

Come artists inform me how it is to be done;
 There are many can tell me, but ask a round sum:
 But knowing there generous persons may be,
 Who will do it for nothing, such will oblige me.

VI. *Question 34, by Mr. Josiah Clayton.*

Sixty thousand brave soldiers in battalia there were,
 Plac'd in a vast plain, and in form a long square:
 Now on how many acres of ground did they stand,
 At two yards, three quarters, between man and man?
 And how many in rank and in file will there be,
 When their length to their breadth is as two is to three?

The Prize Question, by Mrs. Anna Wright.

Within the glorious firmament serene,
 Amongst the constellations there is seen
 The little bear, whose tail's end now doth rowl
 The nearest to the frozen northern pole.
 But what star 'twas, is what I now require,
 O'th' second-magnitude that did appear.
 To be to the north pole the next of all;
 When first God framed this terraqueous ball?
 Since which are years (as best accounts relate)
 Fifty seven hundred and sixteen complete:
 Its distance from the pole, that time pray shew,
 And, when requir'd, I'll do as much for you.

1714.

Solutions to the last year's questions.

* I. *Question 29, answered by Mr. Lingen from Ireland.*

UNhappy man! behold how long you are condemn'd to stay,
 Before your love, your pains to ease, has fix'd the joy-
 ful day;

Till seven and twenty years she's past, relief ne'er hope to find,
 If near that age she has arriv'd, then ease your tortur'd mind.

By

* I. QUESTION 29. *solved.*

Since $\frac{1}{2}$ taken from 1 leaves $\frac{1}{2}$, and this increased by $\frac{1}{4}$ or $\frac{3}{4}$ becomes $\frac{3}{4}$; hence the question is to find a number whose square multiplied by $\frac{1}{8}$ may produce 891.

Consequently, 11 : 9 :: 891 : the square of the number,

$$\text{Or, } \sqrt{11} : \sqrt{9} :: \sqrt{891} : \sqrt{\frac{891 \times 9}{11}} = \sqrt{81 \times 9} =$$

27 = the number sought. I 3.

By Mr. Joshua Lover of Chichester.

S ince 'tis a fair one this request doth crave,
 A loving husband she also shall have:
 R ichly adorn'd with nature's comeliness,
 A nd let true vertue in each heart possess,
 H appy are they thus providence doth blefs.
 B ut since 'tis age this fair one doth require,
 R eady I am to grant her nice desire:
 O f what number, when squar'd nicely and true,
 W hen one ninth, one third being put thereto.
 N ow twenty sev'n doth a right answer shew.

Answered by Mr. Dan. Hatton of Tewkesbury.

To a true lover, I discover,
 The charming maiden's years;
 Which she may find, to ease her mind,
 Just twenty seven years.

* II. *Question 30, answered by Mrs. Adway.*

London, last may the tenth, in morning time,
 I trow, I calculate, or well project,
 The sun's height forty five, the hour was nine,
 Minutes thirteen, seconds twice ten exact.

† III. *Question 31, answered by Mr. John Boswell.*

Six inches, half a quarter, the top did fall,
 By pulling the ladder ten foot from the wall.

And by Mr. T. Bussey of St. Nicholas in Kent.

The ladder's descent must certainly be,
 From th' top of the wall, as here under you see.
 $\cdot 50126 \text{ feet} = 6 \text{ inches } \cdot 01512.$

IV. *Quesf-*

* II. *QUESTION 30. solved.*

Supposing the sun's declination may 10th, 1712, to be $20^{\circ} 16' 32''$; we shall have given the three sides of a spherical triangle, to find an angle: viz. the complement of the declination $= 69^{\circ} 43' 28''$, the complement of the latitude $= 38^{\circ} 28'$, and the complement of the altitude $= 45^{\circ}$, to find the hour angle, or angle between the two former; and which by calculation comes out $41^{\circ} 41' 4'' =$ in time to 2 h. 46 m. 44 s. which being taken from 12 h. we have 9 h. 13 m. 16 s. for the time required.

† III. *QUESTION 31. solved.*

By right-angled triangles, $\sqrt{100^2 - 10^2} = 30\sqrt{11} = 99\cdot4987437$, which taken from 100, there remains $\cdot 5012563 \text{ feet} = 6\cdot0150756 \text{ inches} =$ the number required.

* IV. *Question 32, answered by Mr. Edens.*

Your knotty questions of the farmers, I
By algebraick art do here untye,
All which you ask, exactly I discover,
Because o'th' art, I find you are a lover.

The 1st had $30\frac{8}{17}$ nobles	=	10 <i>l.</i> 1 <i>s.</i> $5\frac{1}{4}$ <i>d.</i>	187.
2d — $44\frac{6}{17}$ —	=	14 14 $4\frac{3}{4}$	888.
3d — $39\frac{12}{17}$ —	=	13 3 5	329.

† V. *Question 33, answered by Mr. John Newbold.*

Those pyramids so often fam'd in story,
For the world's wonder, and for Egypt's glory.
And Babylon so much by the antients prais'd,
Must lose their fame, now your vast fabrick's rais'd.
The Alps, and Pico, seem their tops to droop,
And art bids nature's stately pride to stoop.

The

* IV. *QUESTION 32. solved.*

Putting $a = 86$ nobles, and z, y, x for the 1st, 2d, and 3d person's nobles respectively; we shall have, by the question,

$$z + \frac{2}{3}y + \frac{2}{3}x = a, \text{ Or } 3z + 2y + 2x = 3a,$$

$$y + \frac{3}{2}z + \frac{3}{2}x = a, \text{ Or } 3z + 5y + 3x = 5a,$$

$$x + \frac{5}{4}z + \frac{5}{8}y = a, \text{ Or } 5z + 5y + 8x = 8a.$$

Taking the 1st equation from the 2d, we have $3y + x = 2a$, or $x = 2a - 3y$; this substituted in the 1st and 3d, we have

$$\left. \begin{aligned} 4y - 3z &= a \\ 19y - 5z &= 8a \end{aligned} \right\}; \text{ from 3 times the latter of these equations}$$

subtract 5 times the former, and there will be obtained $37y = 19a$;

$$\text{hence } y = \frac{19a}{37} = 44\frac{6}{17} \text{ nobles} = 14*l.* 14*s.* 4*d.* $3\frac{1}{4}$ *q.* Then $x$$$

$$= 2a - 3y = \frac{17a}{37} = 39\frac{12}{17} \text{ nobles} = 13*l.* 3*s.* $5\frac{3}{4}$ *d.* And $z$$$

$$= \frac{4y - a}{3} = \frac{13a}{37} = 30\frac{8}{17} \text{ nobles} = 10*l.* 1*s.* 5*d.* $1\frac{7}{8}$ *q.*$$

† V. *QUESTION 33. solved.*

Since sound flies 1142 feet in a second of time, we shall have
7 miles \div 1142 feet = 36960 feet \div 1142 = $32\frac{308}{171}$ = 32.36427
seconds = the time of the ascent of the sound.

Again, Since the times of descent are as the roots of the spaces, and
16 $\frac{1}{2}$ feet is the space fallen in the 1st second, wherefore $\sqrt{16\frac{1}{2}}$:
 $\sqrt{36960} :: 1 \text{ second} : \sqrt{\frac{36960}{16\frac{1}{2}}} = 47.93778 \text{ seconds} = \text{the time}$
of the body's descent.

The vast sicilian hill, whose jaws expire
 Thick clouds of dust, and vomit flames of fire,
 Strikes not such wonders in beholders eyes,
 Or stupifies th' amazed faculties;
 The architecture in their works does shine,
 As from the product of a power divine.
 To name the height would be but labour lost,
 Yet 'fear your expectation should be crost,
 The numbers underneath, if manag'd right,
 Will solve th' demand, and give the tow'ring height.
 The time it was falling was 48 seconds.

Answered by Mrs. Mary Nelson.

That lady so fair, (with her standish) i'th' air,
 Let fall from a place so sublime,
 Ere it came to the ground, or made any sound,
 'Twas near forty eight seconds of time.
 But before that her ear the sound could well hear,
 So slowly it made its retreat,
 Great Newton so clear has made it appear
 'Twas forty eight seconds compleat.

I received nine several answers to this question, with some small difference, in regard they calculated the acceleration of descent, and motion of sounds, from different data. Of which numbers were *Pylander*, *Mr. Parker*, *Richards*, *Wilson*, and *Mrs. Sidway*; who supposing the universal measure to vibrate well at the castle, after answering the question, has proposed this following:

Now in return, good sir, be pleas'd to try
 To find the castle's height, when rais'd so high,
 That in what time the standish fell down hither,
 So long the sound was mounting till 't came thither.
 When the weight touch'd the ground, tell what degree
 It had acquired of velocity. VI. *Quas-*

Mrs. SIDWAY'S Question solved.

Putting $a = 16\frac{1}{2}$, $b = 1142$, and $x =$ the height of the castle in feet. Then, as in the last solution, $\frac{x}{b}$ will express the time of the sound's ascent, and $\sqrt{\frac{x}{a}}$ = the time of the body's descent; hence $\frac{x}{b} = \sqrt{\frac{x}{a}}$, and $x = \frac{bb}{a} = 81087\frac{1}{2}\frac{7}{9}$ feet = 15 miles 1887 $\frac{1}{2}\frac{7}{9}$ feet = the height of the castle.

And since the velocity is as the root of the space descended, and $2a$ the velocity acquired by falling through a , we shall have $\sqrt{a} : \sqrt{x} :: 2a : 2\sqrt{ax} = 2\sqrt{bb} = 2b =$ double the velocity of sound, or 2784 feet per second.

* VI. *Quest. 34, answered by J. Lewes of Landkey, Cornwall.*

If sixty thousand soldiers placed so be,
In rank and file, as two is to three;
Place 300 in rank, and 200 in file,
And the question to answer you will not fail.
And on how many acres of ground they do stand,
At eight foot three inches between each man;
I answer, 'tis 92 acres of land. (and 155 Perch.) }

By Mr. Jos. Boydall.

Your sesquialteral oblong squadron must stand
On ninety two acres, and three fourths of land:
And if they do your well-form'd order keep,
The rank's three hundred, and two hundred deep.

I received near 20 answers to this last question: one half of them say, 'tis 93 acres and three quarters. The others, and the proposer say, 92 acres and three quarters, and 35 perches. The former, I suppose, forgot to make the number of distances less by one than the persons. And tho' I received abundance of curious answers to each question, yet I am obliged to omit them, and shall conclude the answers with one sent from Birmingham, that concisely answers all the questions.

Till she's full 27, your preud will not wed:
But sooner by ten years I hope to be sped. Q. 29
The time of the morning (if art we may trust)
Was 9, 13 minutes, 40 seconds just. 30
If the bottom do slide 10 feet from the wall,
The ladder's top down 6 inches will fall. 31
In answer to th' next, you'd think me distracted, 32
Shou'd I put into rhyme these † numbers so fracted.
If a body descends 16 foot (as 'tis reckon'd) 33
And sound moves 1000 feet just, in one second;
Then in 48 seconds the dish came to ground,
And 37 more return'd back the sound.
200 and 300 of the square are the latera, 34
And 92 acres cover'd with a small ‡ &c.

I write short, but talk less, and out I go little;

If you like such a wife, I'm yours, Dor. Dolittle.

† $30\frac{8}{11}$. $44\frac{6}{11}$. $39\frac{1}{2}$. ‡ 92 acres 3 roods.

In this method Mr *Will. Beriff* answered all the questions
except the first. *Answer*

* VI. QUESTION 34. *solved.*

As the sides must be in proportion to each other as 2 to 3, and their product 60000, it is evident that they must be 200 and 300. Then the ground upon which they stand will be $= 299 \times 2\frac{3}{4} \times 199 \times 2\frac{3}{4} = \frac{7199621}{16}$ yards $= 92$ acres, 3 roods, $35\frac{1}{4}$ perches.

* Answer to the Prize Question.

To the prize question proposed last year, I received abundance of letters, in answer, (before Candlemas-day, on which the lots were drawn) out of which there were but four true answers, viz. by Mrs. Barb. Sidway, Mr. Rich. Parker, Mr. John Edens, and H. B. And that so many were mistaken in their answers, there are two reasons. First, In Sir Jonas Moor's and some other catalogues, that star (call'd by Kepler in his Rudolphine Tables Tertia ab Extrema in Cauda Draconis) is accounted of the 3d magnitude, and those who had recourse to these tables, took the middle star in the great bear, or the guard-star in the little bear's shoulder, to answer the question. But those who took Tyco's catalogue, or Seller's northern constellations, where that star is of the 2d magnitude, truly answered the question. A second reason was, (tho' the difference is inconsiderable) some astronomers say the precession of the equinox is 48, and others 50 seconds in a year.

At drawing the lots it fell to Mr. John Edens, who had ten diaries presented to him, and answered thus:

When th' great Jehovah fram'd the skies,

He made the earth and stars likewise,

And plac'd them all, as pleas'd him best,

All rowling from the east to th' west.

Besides that motion, he decreed,

Contrarily they should proceed;

And make their revolution,

Round to the place they first begun:

Which in set times these subjects they

Their mighty monarch's will obey.

If the account is right, as you relate,

Since God did first this earth create,

I th' dragon's tail you may behold

The star which next the north pole rol'd;

And if you view the scheme below,

Its distance from the same you'll know.

The longitude of the first in ♎ 1712 - - - - 29 11 14

The star in Draco from ♎ - - - - - ad. 124 33 30

Longitude of that star, 1712 - - - - - 153 44 44

Moved in 5716 years - - - - - sub. 80 52 53

Remains the long. at the creation - - - - - 72 51 51

Lat. according to Tyco, 66° 36' north. Then.

As the cotan. 23° 30' : is to the radius ::

So is the sine of 72° 51' : to the tang. 22° 33', which subtract from the compl. of the star's lat. leaves 50° 12". Then

As

As the cosine $22^{\circ} 33''$ To the cosine $50' 12''$
 So is the cosine $23^{\circ} 30'$ To the cosine $6^{\circ} 48'$

Six degrees forty eight minutes the distance of that star from the pole at the creation.

Mrs. Sidway's answer.

That star o'th' second brightness that did roll
 At the creation, next the northern pole,
 Some call the dragon's tail; but others say,
 'Tis call'd of tail the antepenultima.
 Its distance then six degrees and one half,
 It has been much nearer, now further off.
 When father Noah threescore was, and odd,
 More than five hundred years before the flood,
 Scarce ten minutes from the pole it stood.*

}
of

* PRIZE QUESTION answered.

The annual precession of the stars being $50^{\circ} 33' 6''$ seconds of a degree, the precession from the creation to the year 1760 will be =

$5716 \div 48 \times 50^{\circ} 33' 6'' = 5764 \times 50^{\circ} 33' 6'' = 290136 \text{ seconds} = 80^{\circ} 35' 36''$. To this precession add 3 signs or 90° , the longitude of the north pole of the equator, and we shall have $58^{\circ} 20' 35' 36''$ for the present longitude of the star required; and the star of the second magnitude, whose longitude is nearest to that, and latitude 66° nearly, was the pole star required; which appears to be the third star in Draco, reckoned from the tip of the tail, which is the star marked, by Bayer, α .

Now to find the distance of this star from the pole at the creation. By the catalogue of stars at the end of the Nautical Almanac for the year 1773, the latitude of α Draconis is $66^{\circ} 21' 15\frac{1}{2}''$, (its complement $23^{\circ} 38' 44\frac{1}{2}''$), and its longitude in the year 1760 was $154^{\circ} 2' 46''$; from this subtract ($80^{\circ} 35' 36''$) the precession since the creation, and we have $73^{\circ} 27' 10''$ for the longitude of this star at the creation, whose complement is $16^{\circ} 32' 50''$: Also, since the diminution of the inclination of the earth's axis is $47''$ in 100 years, in 5764 years its change will be $45' 9''$, which being added to $23^{\circ} 28' 17''$ the inclination in the year 1760, we shall have $24^{\circ} 13' 26''$ for the angle made by the axes of the ecliptic and equator at the creation. Hence in an oblique spherical triangle, we have given two sides and the included angle, to find the third side; viz. given one side = $24^{\circ} 13' 26''$ the distance of the pole of the equator from that of the ecliptic, the other side = $23^{\circ} 38' 44\frac{1}{2}''$ the distance of the star from the pole of the ecliptic, and the included $\angle = 16^{\circ} 32' 50''$ the complement of the star's longitude: Then, by trigonometry, is found the 3d side = $6^{\circ} 43' 10''$ the required distance of the star from the pole of the equator at the creation.

Of the Eclipses.

An eclipse of the sun is caused by the interposition of the moon's dark body between the moon and our sight, for the moon being then under the sun, doth come in a direct line between the sun and our eyes, and so by the thickness and opakeness of her body doth obumbrate and hinder the sun from shining upon us; and this always happens at the conjunction of the sun and moon, or new moon, but not at every new moon; but only when the conjunction falleth in or near to either of the nodes, at which time she hath little or no latitude from the ecliptick.

An eclipse of the moon is caused by the direct interposition of the earth between the sun and her; then these three great bodies are all in one diametrical and straight line, the dark body of the earth being between the sun and moon, doth hinder the beams from shining on the moon, and so the moon having no light of her own, but what she receiveth from the sun by reflection, doth really become dark: and these eclipses always happen at full moon, but not at every full moon, but at such when she is in or near the ecliptick. And although

There will happen four eclipses this year 1714, yet not one of them will be visible in England.

The first eclipse is of the moon, on the 18th day of may, half an hour after 7 in the morning, but not visible to us, the moon being then set, but may be seen in Newfoundland - in America.

The second is of the sun, the 1st day of june, invisible.

The third is of the sun, the 27th of october, at 5 in the evening, the sun being then set, therefore invisible to us.

The fourth eclipse is of the moon, the 10th day of november about noon, invisible.

These eclipses this year being so inconsiderable, I will give you an account of as great an eclipse as has happen'd in England these 50 years. It is of the sun, the 22d day of april, 1715, beginning 6 minutes after 8 in the morning, and lasts above two hours: the sun will be so totally obscured for the space of 2 minutes and a half, that the stars will appear as though it was night. A full account of this eclipse you shall have in my next.

New

New Arithmetical Questions.*

I. *Question 35, propos'd by Mr. John Wilfon.*

Assist you ladies, that in art are skill'd,
And have the bitter sweets of love once feel'd;
You I invoke, and on your aid rely,
To help me in my great'st extremity.

Oh! how the scene is chang'd, as in a trice,
I who could others counsel, want advice.
My sweet Eliza was so charming fair,
That Dian's nymphs might none with her compare:
Nor was her face so charming as her mind,
Her chaste love free, and to her swain was kind.
But above all, her intellectual part
Was virtuous, witty; constant was her heart.

This render'd me, when in Eliza's arms
I lay, incircl'd 'midst a thousand charms,
The happy'st mortal breathing on the earth:
But now my torment's far more worse than death,
Till you, fair ladies, your assistance lend,
And give an answer to the lines I send.

Eliza's father, cruel both to me
And to my dear Eliza, furiously
Snatch'd my dearest from m'encircling arms,
And utterly denies our future charms,
Till I shall count the portion of my dear,
And what he's worth in all, to him declare.
' Three sevenths of 's estate my dear's to have:
' The other four to his own use he'll save.
' Now what's estate is worth I fain would know;
' But he no more than this will to me show:
' The pounds being cub'd, the product of that sum
' Will to a number of nine figures come:
' Which by the squares of eight and three divide,
' And in the quotient still there will abide
' Thousands three hundred fifty two, and more,
' Nine hundred forty seven: On which I pore
Both day and night; but I no good can do:
Therefore my whole dependence lies on you.

II. *Question 36, by Mrs. Barbara Sidway.*

A gardiner he had an upright cone,
Out of which should be cut him a rolling stone,
The biggest that e'er it could make.
The mason he said, that there was a rule
For such sort of work, but he had a thick skull.
Now help him for pity's sake.

Mathem.

K

III. *Quef-*

III. *Quest. 37, by Mr. John Hodge, of Truro, in Cornwall.*

Two esquires of late, of noble estate,
 Once happ'ned to fall at discord;
 Their wrath grew so high, nothing could pacifie,
 But the law or the point of the sword.
 Their counsellors were a jolly brisk pair,
 And having good clients in hand,
 Resolved to use them as friends (not abuse them)
 As by this you may understand.
 In tavern being met, they concluded it fit
 This matter in law to delay,
 So long as they nine could change places to dine,
 And make but a change ev'ry day.
 How long must they sit, tell I pray?

IV. *Quest. 38, by Mr. Crabb of Whitlackington in Somerset.*

A gentleman with his artif'cer did
 Agree for building a round pyramid;
 And for each foot solid the same did contain,
 Seven pence was the price; no more, loss or gain:
 And now, I must tell ye, it was his good pleasure
 To have it be made, just after this measure;
 That when it was rais'd, in inches six score,
 Twelve hundred and fifty foot solid be more
 Built thereon: and let the height in this case,
 From the top o'th' same, to the center o'th' base
 Be in proportion to the circuit there,
 As five is to four: and now observe here,
 'Twas also agreed, that for the same pay,
 To have a room in't, made square ev'ry way,
 As large as the cone would admit of, I say.
 But I am in doubt, he can't do't alone:
 Pray help him therefore in building this cone.
 And th' girt at the base, with th' height to him give,
 With the side of th' room, and what he must have
 For building this cone, is all I do crave.

V. *Quest. 39, by Mr. Richards, of St. Thomas's, nigh Exon.*

The first king of Assyria, Ninus by name,
 Took to wife Semiramis, that valorous dame,
 Who repair'd old Babylon, when 'twas decay'd;
 And by her great courage made her foes afraid.
 But one thing to her fame I think proper to quote,
 Which is of all others the most proper to note:
 'Tis that obelisk of marble she caus'd to be set
 From the armenian rocks, and in Babylon set.

It

It was pyramid like; the base twenty foot square,
 'Twas of one solid stone, and (as authors declare,
 If measur'd) one hundred besides fifty foot high:
 This carriage was prodigious, you'll quickly reply.
 Now (pardon the wildness of my fancy) suppose
 Being sunk in Euphrates, it were thence to be rose,
 What weight were sufficient this stone to raise up,
 Till the point of the same should appear at the top,
 Or surface o' th' water? besides how much weight more
 Must be added to bring it as it was before
 It was such? I mean, the whole stone above water;
 For when we have done this, we have finish'd the matter:
 For I hope they'll take care and not sink it again,
 If Euphrates salt water its weight will sustain.

VI. *Question 40, by Mr. John Newbold.*

In walking the street, I met with a brisk blade,
 An honest old lad, and a cooper by trade:
 He was merry in mind, but his whistle was dry;
 You'd have laugh'd your guts out in hearing him cry
 Any buckets or tubs, any barrels to mend;
 Here's hoops of all sizes: pray make use of a friend.
 I observ'd him a man of abundance of tattle,
 And that most of his knowledge consisted in prattle;
 Then resolv'd with myself that I'd give him a rub;
 So I ask'd him to make me a conical tub;
 Its base thirty inches, and a hoop there so wide
 Should, if placed upright, the whole tub circumscribe;
 And with the four ends of the diameters right,
 And hold in ale gallons, nineteen ninety eight. (19'98)
 To work he freight went; but soon found that his skill
 Was too shallow the problem propos'd to fulfill:
 So desires in this letter the favour from you,
 To send the request underneath very true:
 The depth of the tub, and diameter least,
 And hopes that the ladies will grant the request:
 And as a reward (now his brains are grown dunch)
 He'll treat them next year with a tub full of punch.

*The PRIZE QUESTION, of 10 Diaries, to be determined by
 Lot among those who answer it before Candlemas.*

[As this Question is propos'd in very bad-verse, I shall
 here turn it into plain prose.]

In gauging a spheroidical ale cask, I found the diameter of
 one head to measure 18'1 inches, that of the other 16, the
 bung diameter 20, and the distance between the two heads 20'6
 inches; also, by the cask lying a little obliquely, I observed
 K 2 that

that the liquor just rose to, or touched, the upper extremities of the two heads. Having noted these dimensions, I was informed that there were in the cask a ball of iron weighing 60*lb.* another ball of lead weighing 90*lb.* and a cube of box, a foot square. Pray what quantity of liquor was in the cask.

1715.

Solutions to the last year's Questions.

- * I. *Question 35, answered by Mr. Peter Walter, and Mr. Ja. Cole, of Portsmouth.*

GOOD sir rejoyce, now you your point shall gain,
 And in your arms your charming fair detain;
 Then to her father with assurance go,
 Tell him you do his daughter's portion know,
 For 'tis the number which you find below. }
 The father's estate, 588*l.* The daughter's portion, 252*l.*

The same answered by Mr. William Vorley, writing master at Holbech, Lincolnshire.

You may marry Eliza as soon as you will,
 For I've found out her father's estate by my skill
 In arithmetick, if that I be right,
 To be pounds five hundred eighty and eight;
 Yet to be more kind, unto you I'll shew,
 That pounds two hundred fifty and two, }
 Is her just portion. I joy her to you.

This question was answered by Mr. Moyle, Mr. Hatton, Mr. Shepheard, Mr. Crabb, Mr. Lingen, Mr. Cooch, Mr. Beriff, Mrs. Jone Jolly, Mr. Hall, Mr. Elphick, Gynæphilus, Mr. Hayward, Mr. Carter, Mr. Ragg, Mr. Widdows, Mr. Woodham, Mr. William Bainham, Mr. Edens, Mrs. Nelson, Mr. Williams, and others.

II. *Ques-** I. QUESTION 35. *solved.*

Since the cube of the number of pounds in the whole estate is equal to $352947 \times 64 \times 9 = 203297472$, the number itself must be equal to the cube root of this number, which is 588*l.* = the whole estate. Consequently $\frac{2}{3}$ of 588 = 252*l.* is the lady's portion

* II. *Question 36, answered by Mr. Newbold.*

Honest mason, thro' Mrs. Sidway's perswasion,
 I'll shew you the way for to cut
 The greatest cylinder out, of all cones without doubt,
 And this is the way you must do't:
 Through the middle of its height, cut the cone right
 To its axis, and then you will find,
 A cylinder in this case, must have such a base,
 For the greatest to be of its kind.

Mr. Beriff, Mr. Hall, Mr. Wylde, and Mr. Clayton, say it must be cut thro' $\frac{1}{3}$ of its height, agreeing to the proposer. Mr. Williams, Mr. Andrews, Mr. Grabb, and Mr. Cole answered this question.

† III. *Question 37, answered by Mr. Tho. Dodd.*

May such amusements always end rash strife,
 Destructive of the peaceful sweets of life:
 Had they but sat each day in diff'rent range,
 And liv'd to see how often they could change,
 They'd seen more days than all *Methuselah's*
 Just twenty four, with six and nine score days.

And by Mr. Lingen, and Mr. Nath. Kew, of Bath.

How few can we find, so good of that kind,
 So generous, so wonderful civil;
 I have felt the curst claws of some traders in laws:
 Deliver us Lord from that evil.

They must have continued 993 years, and 186 days.

IV. *Quest-*

* II. *QUESTION 36. solved.*

From several solutions that have been given of this question, it is very certain that the cone must be cut at *one-third* of its altitude.

† III. *QUESTION 37. solved.*

The time required will be $= 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 \times 9 = 362880$ days; which, at $365\frac{1}{4}$ days to the year, come to $993\frac{3}{4}$ years.

- * IV. *Question 38, answered by Mr. John Newbold, Mr. Lewis Evan, Mr. Abel Ragg, Mr. John Andrew, Mr. Nich. Stevens, and Mrs. Nelson.*

What human pleasures more delight the mind,
Or solid notions satisfaction find,
Than centred are in mathematick skill;
The sweet endowment of that splendid quill.
—— The question 38 is so sublime,
It makes the nine harmonious numbers chime
Into a theorem of a high degree,
Sur-solid much affected it will be;
Which I determine by converging series,
And underneath have solved all its queries.

The circumference of the pyramid at the base	feet	inch.
The whole height of the cone	41	6
The side of the room	51	10
	7	11

The content in solid feet when the room is deducted,
1878.1093. The charge of the building, 54*l.* 15*s.* 6*d.*

V. *Quest.*

* IV. QUESTION 38. *solved.*

Put $a = .785398$ &c. and $5x$ and $4x$ for the altitude and circumference of the upper part whose content is 1250. Then its solidity is $\frac{5x^3}{3a} = 1250$; hence $x = \sqrt[3]{750a} = 8.381697$. Consequently the altitude of the whole cone $= 5x + 10 = 51.913485$ feet $= 51$ feet 10.96182 inches, and the circumference of its base $= 4x + 8 = 41.53078$ feet $= 41$ feet 6.369456 inches: Also, by similar solids, $5x^3 : (5x + 10)^3 :: \left(\frac{5x^3}{3a} = 1250\right) : \frac{(x+2)^3}{x}$
 $\times 1250 = 2375.14 =$ solidity of the whole cone.

Now, if $A = 5x + 10 = 51.913485$ the altitude of the whole cone, and $z =$ the side of the inscribed cubical room; by similar figures we shall have $A : \frac{A}{10a} :: A - z : \frac{1}{2}z\sqrt{2}$; hence $z = \frac{A}{1 + 5a\sqrt{2}} = 7.921364$ feet $= 7$ feet 11.056368 inches $=$ the side of the room; the cube of which gives 497.05 for the vacuity.

Taking this from the whole solidity (2375.14) we obtain 1878.09 for the solid part; which, at 7*d.* a foot, produces 54*l.* 15*s.* 6*d.* 2.52*g.*

* V. Question 39, answered by Mr. Newbold.

When noble thoughts invest a noble soul,
 And martial ardours all the mind controul;
 When female spirits dare encounter those
 Sad dangers we to fancy scarce suppose;
 Dashing their courage through their splendid eyes,
 And master danger with the least surprize:
 Oh! Semiramis, what strange acts I find
 Recorded of thy elevated mind,
 Especially the stately pile thou'lt set
 In *Babylon*, has made thy works complete,
 And set the poets wits at strife to feign
 Sufficient words t' immortalize thy name.
 Some fain would know how much 'twill weigh
 when in the air, and in the sea.
 And for to please the minds of those
 Their whole requests I here disclose.

				<i>Tun.</i>	<i>cwt.</i>	<i>qr.</i>	<i>lb.</i>
To raise it to the surface	—	—	—	939	3	2	10
To be added to raise it out	—	—	—	573	12	3	25
The weight in the air	—	—	—	1512	16	2	7

This calculus is according to Mr. *Ward's* tables of specific gravities, and differs considerable from those taken from *Philosophical Transactions*.

To this question I received true answers from Mr. *Peter Ward*, Mr. *Tho. Fearne*, Mr. *Crabb*, Mr. *Beriff*, Mr. *Hall*, Mr. *Edward Elphick*, Mr. *Abel Ragg*, Mrs. *Mary Nelson*, and Mrs. *Carrington*.

To the 40th question I received but one answer, from Mr. *Edens*; although I conceive the question very well explains the meaning, yet I find most persons were at a loss in answering it. 'Tis no more but to find a frustrum of a cone that

* V. QUESTION 39. solved.

The solidity of the pyramid will be $20^2 \times \frac{150}{3} = 20000$ feet = 34560000 cubic inches. Now by *Ward's* table of specific gravities, a cubic inch of marble weighs 1568859 ounces avoirdupois, and an inch of salt water 594894 ounces; and their difference is 973965. Whence, the weight required to raise the point of it to the surface of the water will be $973965 \times 34560000 = 33660230402 = 939$ tons 3 cwt. 2 qr. 12 lb. 6.4 oz.

And it is evident that the whole weight of the marble will be necessary to raise the whole of it above the water.

that will hold 19 gallons, and 98 hundred parts, whose greatest hoop's diameter is 30 inches, when placed perpendicular to the vessel, shall touch the two ends of each diameter, the least diameter must be 18.236 inches, and depth 11.9104 inches.*

Mr. Richard Ford answer'd all the fix questions in one copy of verses, which came too late to be inserted.

Answer to the Prize Question.

To the prize question propos'd last year, I received a considerable number of answers; but the difference among authors concerning the specifick gravity of metals, and the various theorems by which they found the content of the cask, and its vacuity, caus'd some (tho' inconsiderable) difference. It would be endless, as well as needless, (in my small room) to give you an account of the whole operation, which could not well be explain'd without a figure of the spheroid, and the algebraick theorems deduced therefrom, and would thereby be troublesome, as well as uncommon in a work of this nature; I shall therefore omit that, and only insert so much as answers the demands in the question.

Mr.

* VI. QUESTION 40. *solved.*

Put $2a = 30 =$ the bottom diameter, $2x =$ the top diameter, and $A =$ the content in ale gallons. Then, by the nature of the circle, $\sqrt{aa - xx} =$ the perpendicular depth; and, by page 159 Mensuration, we have $4 \times aa + ax + xx \times \sqrt{aa - xx} \times \frac{78539 \&c.}{3} = 282A$, where $282 =$ the inches in a gallon; or

$$aa + ax + xx \times \sqrt{aa - xx} = \frac{846A}{3 \cdot 14159 \&c.}$$

Now when $A = 19.98$ as in the question, there is no number, taken as the value of x , will produce so great a content, the number 19.98 being above the maximum. But to find the greatest content the case will admit of, put the fluxion of $aa + ax + xx \times \sqrt{aa - xx} = 0$ nothing, and we shall have $0 = aa - xx \times a + 2x - x \times aa + ax + xx = a^3 + a^2x - 2ax^2 - 3x^3$; or in numbers $x^3 + 10x^2 - 75x - 1125 = 0$; or, putting $z = \frac{1}{3}x$, $z^3 + 2z^2 - 3z + 9 = 0$; the root z of this equation is $= 1.9394$; consequently $2x = 10z = 19.394 =$ the value of the less diameter when the content is a maximum; and then the depth $\sqrt{aa - xx}$ is $= 11.444$, and the greatest content $= \frac{30^3 + 30 \times 19.394 + 19.394^2}{3} \times \frac{11.444}{282} \times \frac{78539 \&c.}{3} = 19.739$ ale gallons.

Mr. *John Newbold*, and Mr. *John Edens*, have geometrically demonstrated, and algebraically wrought each demand. An abstract of which follows after Mr. *Edens*' answer in verse.

To the ingenious sons of art I write,
 Who in the mathematicks take delight.
 To censure others 'tis not my intent,
 But to the gauger my respects present.
 Hard was his fate that he this barrel found,
 Such are not common in a gauger's round;
 For if they were, others as well as he,
 Would often at their *ne plus ultra* be:
 At his request I here send my assistance,
 And from each head to th' bung the distance,
 And what the barrel holds I make appear,
 And what remains, tho' vulcan's craft was there.
 Now since this task did pose the gauger so,
 Pray shew to him what I have done below.

	inches
The spheroid's greatest distance from bung to head	12'033
The lesser distance — — — — —	8'547
The content of the cask in ale gallons — —	20'763
<hr/>	
The iron ball equal to cubick inches — —	217'048
The leaden ball — — — — —	219'717
The cask's vacuity — — — — —	117'814
The box emerged — — — — —	1723'000
<hr/>	
The sum, cubick inches — — — — —	2277'579
which are equal to ale gallons	8'076
which deducted from the whole content leaves	12'687
ale gallons, the true quantity of liquor remaining in the cask.	

At drawing the lots, Mrs. *Anne Morgan* won the prize.

Mrs. *Mary Nelson*, of *Newmarket*, answers thus.

Alas poor man! you're in a sad condition;
 Who can refuse to answer your petition?
 If th' ladies grant you not relief with speed,
 You may at last be so reduc'd indeed,
 To ride like *Hudibras*, on such a steed.
 But since you are in such a pitious case,
 For once, I'll save your credit and your place:
 Here underneath I've answer'd all your queries,
 Which gives me one fair chance to win the diaries.
 (*Here follow'd the answer as above.*)

Mr.

The Prize Question answered by R. Sandford.

Well, look you here good question spoil'd,
 Cot knose was nere fee like, fir;
 Was put good ale for verjuice, child,
 Splut was in a passion straight, fir.
 (*The answer as above.*)

Besides

$$\text{And, } \sqrt{EK \times KB} : KC :: BH : HM = \frac{BH \times KC}{\sqrt{EK \times KB}} = \frac{120.537}{6} = 20.0895.$$

$$\text{Also, by right-angled } \triangle s, AC = \sqrt{CL^2 + LA^2} = \sqrt{20.6^2 + 1.05^2} = 20.62674; \text{ and sine of } \angle ACL = \frac{LA}{AC} = 0.0509048 = \text{sine } \angle NHM, \text{ which put} = s, \text{ and its cosine} = c.$$

Then, by the nature of the ellipse,

$$MH^2 : HB^2 :: MH^2 - HO^2 : ON^2;$$

but $HO = HN \times c$, and $ON = NH \times s$, wherefore

$$MH^2 : HB^2 :: MH^2 - HN^2 \times c^2 : HN^2 \times s^2, \text{ or}$$

by subtraction

$$MH^2 - HB^2 : HB^2 :: MH^2 - HN^2 \times s^2 + c^2 : HN^2 \times s^2, \text{ or since } s^2 + c^2 = 1$$

$$MH^2 - HB^2 : HB^2 :: MH^2 - HN^2 : HN^2 \times s^2, \text{ or}$$

$$\overline{MH^2 - HB^2} \times s^2 : HB^2 :: MH^2 - HN^2 : HN^2, \text{ and by addition}$$

$$\overline{MH^2 - HB^2} \times s^2 + HB^2 : HB^2 :: MH^2 : HN^2, \text{ and hence}$$

$$NH = \frac{MH \times HB}{\sqrt{HB^2 + s^2 \times MH^2 - HB^2}} = \frac{MH \times HB}{\sqrt{HB^2 \times c^2 + MH^2 \times s^2}} = 20.01094.$$

$$\text{Also, its semi-conjugate } PH = \sqrt{MH^2 + HB^2 - HN^2} = 10.15629.$$

$$\text{But } HR = \frac{IH - GH}{2} = 1.7537; \text{ and } RQ = \frac{GA + IC}{2} =$$

$$6.525; \text{ and, by right-angled triangles, } HQ = \sqrt{QK^2 + RH^2} = 8.703511; \text{ consequently } QP = PH - HQ = 1.45278.$$

Then,

Besides the above-specify'd, these following answer'd it:
Mrs. B. Sidway, Mr. N. Stephens, Mrs. Staples, Mr. John Whittingham, Mr. Boswell, Mr. Ford, Mr. Berriste, Mr. T. Fenton, Const. Love, Mrs. Hill, and Mr. Mouse.

You tell us a tale of a tub of good ale,
 That can buoy up the box in the liquor;
 But 'twas fill'd with rum, or else sure with mum,
 Or something still stronger and thicker.

The Eclipses of this Year.

Twice this year, 1715, shall the earth in part be deprived of the sun's illuminating radiancy, by the interposition of the opacous body of the moon; and twice also shall the moon be deprived in part of her sun borrow'd lustre, by reason of the earth interposing between the sun and her.

The first is a great eclipse of the sun, on friday the 22d of april, at 9 in the morning; visible to us in England.

The

Then, by cor. 2 page 275 Mensuration, the content of the segment APC will be $3.14159 \&c. \times MH \times HB^2 \times QP^2 \times \frac{HP - \frac{1}{3}PQ}{PH^3} = 122.9787$ inches = the vacuity.

But the content of the box cube is $12^3 = 1728$; all of which will be immerfed, because it is heavier than ale. Also, using Ward's table of specific gravities, the solidity of the iron ball will be $\frac{60 \times 16}{4.422979} = 217.0483$; and that of the leaden one $\frac{90 \times 16}{6.553885} = 219.717$.

The sum of these three added to the above segment, gives 2287.744 for the sum of the deductions.

Now the content of the whole cask is $2EB^2 + FA^2 \times .2618HG + 2EB^2 + CD^2 \times .2618HI =$
 $2EB^2 \times GI + FA^2 \times HG + CD^2 \times HI \times .2168 = 5855.3142$.

From this whole content then taking the above sum of the deductions, we obtain 3567.5702 inches; which divided by 282, we have 12.65096 for the number of gallons required.

	d.	h.	m.	s.
The equal time of the true \odot at Coventry, april	21	21	17	7
The time of reduction subtract.	—	—	3	12
Equal time of the true conjunct. of the ecliptick	21	13	55	
The equation of time add.	—	—	16	23
The apparent time of the true \odot	21	30	18	
Interval of the true and visible \odot subt.	—	—	19	57
Interval of the vis. \odot and greatest ob. sub.	—	—		2
The hourly motion of the D from the \odot	—	—	35	26
The beginning of the eclipse 22d apr. morn.	8	6	6	
The beginning of total obscuration	—	—	9	9 3
The middle or greatest obscuration	—	—	9	10 19
The visible conjunction	—	—	9	10 21
The end of total obscuration	—	—	9	11 36
The end or full recovery of sun's light	—	—	10	19 9
The whole duration	—	—	2	13 3
				The

* This eclipse was observed in England as here follows.

Places	Observers	Begin.	Immer.	Emers.	For.	End.
		h. m. s.	h. m. s.	h. m. s.	m. s.	h. m. s.
Barton	M. Bridges				3 53	
Bell bar	M. Jones	8 6 25	9 9 45	9 13 27	3 42	
Broadway } Carmarth.			8 47 0	8 49 30	2 30	10 21 57
Cambridge	M. Cotes			9 14 37		10 24 30
Canterbury	M. Gray	8 10 0				
Chester	M. Ward	7 57 40				10 6 35
Crew	M. Wright		9 2 8		2 0	10 9 0
Dublin	L. Archbish.	7 42 11				9 49 40
Dublin	M. Hawkins	7 41 30				9 48 45
Exon	L. Bishop		8 55 0	8 59 0	4 0	10 0 0
Exon	M. Hudson	7 47 30			3 30	10 0 30
Greenwich	M. Flamsteed				3 11	
King's Wald.	M. Whitside				3 52	
Llanidan } Anglesey	M. Rowland	7 52 30				
London	R. Society	8 6 0	9 9 3	9 12 26	3 23	10 10 0
Northamp.	M. Hawkins		9 5 22	9 9 24	4 2	10 15 35
Norton-court	D. Harris	8 8 55	9 13 23	9 14 22	0 59	10 24 47
Oxon	D. Keill				3 30	10 15 10
Plymouth	M. Heines	7 41 0	8 45 30	8 50 0	4 30	9 54 30
Portchester	C. Chandler		9 2 25	9 6 15	3 50	
Salop	D. Hollings	7 58 0			1 40	10 6 0
Upminster	M. Derham	8 7 41	9 10 58	9 14 6	3 8	10 21 45
Wansted	M. Pound	8 6 37	9 9 28	9 12 48	3 20	10 20 32
Weymouth	M. Hobbs		8 53 0	8 58 0	4 0	
Witley	M. Baxter	7 59 0			3 15	10 13 0

Mathem.

L

The

The digits eclipsed are 12 d. 10 m. 16 s.

The lat. of the moon seen at the begin. $0^{\circ} 20''$ south asc.

The lat. of the moon seen at the end, $0^{\circ} 50''$ north asc.*

This eclipse will be central in the nonagesime degree, in the lat. $59^{\circ} 54''$ north, and long. eastward from Coventry $10^{\circ} 30''$ in the south east parts of Norway.

The second eclipse is of the moon, on saturday the 7th day of may, half an hour after 1 in the afternoon; so invisible to us.

The third is a solar eclipse, falling on sunday the 16th day of october, at 11 in the morning.

The fourth is a visible eclipse of the moon, monday october the 31st, at 4 in the morning.*

The

The center of the shade entered England about Plymouth, and passed over Exeter, the Devizes, Islip, Buckingham, and Hunting-ton, leaving Oxford and Bedford on the right, and Lynn on the left, and quitted the coast of Norfolk about Wells and Blakeney. Its course making an angle of $52^{\circ} 45'$ with the meridian eastwards from the north. And its velocity 29 geographical miles in a minute of time very nearly.

In some other places it was thus observed.

Places	Observers	Begin.	Greatest Obscurity	End	Quant. eclipsf.
		h. m. s.	h. m. s.	h. m. s.	dig. '
Paris	R. Academy	8 11 0		10 28 0	
Nuremburg				11 10 12	
Hamburg		8 57 0	10 5 30		11 30
Kiel in Holst.	J. H. Hoffman	9 14 0	10 19 20	11 29 0	11 20
Berlin			10 22 0	11 34 1	11 0
Franckfort		8 50 0	10 0 1	11 10 0	10 34
Pirna	D. Schmiderus	9 15 0	10 30 0	11 32 0	10 0
Dantzick		9 40 2		12 2 40	
Warsaw		9 49 0			
Parma	P.A. Beccadelli	8 45 5		11 0 45	

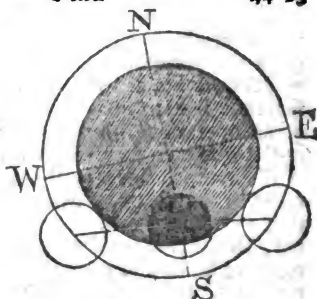
* This eclipse was observed at *Wansted* by Mr. J. Pound thus.

App. time	
h. m. s.	
15 9 0	The eclipse had been for some time begun.
16 15 47	The middle.
17 38 20	The end.

The digits eclipsed were $8\frac{1}{2}$. The moon's diameter $33' 40''$.

	d.	h.	m.	s.
The equal time of the true opposition at } Coventry, october — — — }	30	16	16	31
The time of reduction add. — — —			2	56
The correct time of the true opposition in } the ecliptick. — — — }	16	19	27	
Equation of time add. — — —			3	56
The apparent time of the opposition — —	16	23	23	
Interval of the true 8 and greatest obsc. s.			5	52
The beginning the 31st october, morning —	2	58	29	
The middle or greatest obscuration — —	4	19	31	
The end at — — — —	5	36	33	
The whole duration — — — —	2	38	4	
The digits eclipsed 7 d. 51 m. 19 s. nor.				
Latitude of D south desc. at the { beginn.	35	43		
{ end	44	25		

*A type of the lunar eclipse
the 31st of october, a quar-
ter after 4 in the morning.*



I gave you an account last year, that the sun's eclipse on the 22d of april, is the greatest that (I can find) has happened in England these 60 years, or perhaps a much longer time, or that will happen for so long yet to come. I do not find that anno 1653, was total.

There will be two very large eclipses of the sun, one on the 11th of may, 1724, at 6 at night; the other on the 14th of july, 1748, between 10 and 11 in the morning. There will, before the year 1762, be 16 total eclipses of the moon, and 31 partile eclipses. As also 15 visible eclipses of the sun, 9 of which will be very considerable ones; an account of these you may meet with in some of my next.

Of the excellency and usefulness of Mathematical Learning.

In all ages and countries where learning hath prevail'd, the mathematical sciences have been looked upon as some of the

the chief and most considerable branches of it. And amongst the seven liberal arts, no less than four of them are mathematical; namely, arithmetick, geometry, musick, and astronomy. There is no science in the world, that does improve the mind of man, so much as this; by giving it a habit of close and demonstrative reasoning; by freeing it from credulity, prejudice, and superstition; by rendering it exact, and capable of solving the greatest difficulties; and lastly, by regulating the imagination, and giving the mind the greatest extension and capacity that human nature is capable to attain.

The usefulness of this science is almost infinite, there being scarce any knowledge, art, or science in the universe, but may be assisted and advanced by it. And indeed it is to this science we owe the vast improvements of natural knowledge in these last ages, and some of the most noble inventions of the world.

Arithmetick is an art more liberal than all the rest; for it makes ready payment for our diligence, in that it instantly gives the demonstration of its operations, and sets no lesson which does not at the same time display the perfection of its secrets. It has this in particular, That you may find in each of its operations, that perfection which is vainly sought for in the whole circle of other arts.

Without it trade would go near to ruin: What would become of the nation, if by it were not kept the public accounts that regard the state of the common-wealth, as to the number, fructification of its people, increase of stock, improvement of lands and manufactures, ballance of trade, publick revenues, coinage, military power by sea and land? Of which no person can truly judge without subjecting them to calculation.

Is it not by this and geometry, that all mensurations of plains, as board, glass, painting, &c. and solids, as timber and stone, are performed, and sold by measure as well as cloth. Workmen are paid the due price of their labour, according to the superficial or solid measure of their work. And the quantity of liquor determined, for a due regulation of their price and duty.

By these and trigonometry are performed those useful parts, as measuring accessible and inaccessible heights and distances by sea and land, laying down plans of particular lordships, inclosures, and taking maps of countries. What fortifying, attacking, defending, bombing, mineing, or quartering and embatailing of armies, could be performed without the assistance of arithmetick and geometry? How is it but by these arts, that building of houses and ships, the making of telescopes, microscopes, spectacles, and all other optick glasses; the calculating of clocks, watches, and sun-dials, and all
mechanick

mechanic engines and instruments, are demonstrated and made?

Nor is its use less inferior by sea in the art of navigation, on which the riches and security of the kingdom depend. How vain and unsuccessful would the merchant's pretensions be to fetch home riches from any part of the world? Could the navigator ever hope to find his way (after a storm) by sea, without the help of astronomy, to know longitude and latitude, by the sun, moon, and stars, and the other planets and their satellites in the observation of their distances, oppositions, conjunctions, eclipses, rising, setting, culminating, &c.

Our ignorance of the ebbing and flowing of the tides would argue a want of astronomy, as also the times and seasons of the year, the observation of the festivals and fasts of the church, according to the first primitive institution, could not be kept to a due disposition, as to the return of the seasons and the sun's motion.

Nothing surely can more illustrate and give greater life and glory to astronomy, and animate its professors, than the generous encouragement her late sacred majesty and parliament have now been pleased to give, by settling a reward of twenty thousand pounds, on such person or persons as shall discover a more certain and practicable method of ascertaining the longitude, than any yet in practice. And although astronomy is in these days arrived to a great perfection, yet are there (I doubt) wanting a long series of observations of the heavenly bodies, to effect the same.

It was the opinion of some about 1630, that longitude might be found by the observation of something below the moon. In pursuance whereof, Mr. *Henry Bond*, a mathematician, after 38 years study and observation in 1676, publishes a treatise, entituled, *Longitude found, by the magnetic inclinatory needle*; which was by his majesty's appointment examined by six commissioners, celebrated men of their time, viz. Seth, Lord Bishop of Sarum, the Lord Brunker, Sir Samuel Morland, Col. Titus, Dr. Pell, and Mr. Hook; and was farther confirmed by several observations in the freights of Magellan; for encouragement of which, his majesty king Charles II. was graciously pleased to grant his royal licence for publishing the same, with privilege for 15 years, dated 28th june, 1676. But it seems this fell short of its end, as all the methods of our modern pretenders to longitude have yet done. I heartily wish it may be the glory of our age to find the same.

But as 'tis needless to say thus much of a science that illustrates its uses and perfections daily, I can but admire who would be ignorant of its excellency, use, and benefit to

mankind? Who would not take some pains, to attain a competent knowledge of an art so truly valuable? I am confident there is no thoughtful and contemplative person but would find pleasure and satisfaction in the study of it. 'Twas from these considerations, that in my vacant hours I have (tho' meanly) endeavour'd to introduce some parts of it into the world, by the ensuing method.

Some Paradoxes proposed, to be answered next year.

A paradox is a seeming falsity, but a real truth; it is that which to unthinking persons seems absurd, or impossible, but to a thoughtful man is plain and evident; the main drift whereof is to whet the appetite of an inquisitive learner, and set him upon thinking. Although (says an ingenious author) the soul of man is a cogitating being, and its thoughts so nimble as to surround the universe itself in a trice; yet so unthoughtful, and strangely immur'd in sense, are the generality of persons, that they need some startling noise to rouse and awake them.

The proposing a paradoxical truth to the intellect, immediately summons all the powers of the soul together, and sets the understanding on work to search into, and scan the matter. 'Tis no trivial business to awaken the mind of man to its natural act of thought and consideration. If therefore these ensuing paradoxes shall obtain this end, it matters the less if some of them, upon strict enquiry, should be found to consist of equivocal terms, or perhaps prove little more than a quibble at the bottom.

1. *A Paradox by Mr. Moyle.*

Christians the week's first day for sabbath hold;	}
The jews the seventh day (as they did of old);	
The turks the sixth (as I have been told).	
Now, good sir, pray tell to me,	
How it is possible this thing can be,	
That ever a christian, jew, and turk, these three	
Being all together in one place, may,	
In and upon one and the self-same day,	
Have each his own true sabbath? tell, I pray.	

Some Geographical Paradoxes from an ingenious author.

Par. 2. There is a particular place of the earth, where the winds (tho' frequently veering round the compass) do always blow from the north point.

Par,

Par. 3. There is a certain hill in the south of Bohemia, on whose top, if an equinoctial sun-dial be duly erected, a man that is stone blind may know the hour of the day by the same, if the sun shines.

Par. 4. There is a vast country in Ethiopia superior to whose inhabitants the body of the moon doth always appear to be most enlighten'd when she's least enlighten'd; and to be least when most.

Par. 5. There's a large and spacious plain in a certain country in Asia, able to contain six hundred thousand men drawn up in battle array; which number of men being actually brought thither, and there drawn up, it was absolutely impossible for any more than one single person to stand upright upon the said plain.

Par. 6. There are three distinct places on the continent of Europe; equidistant from one another, (they making a true equilateral triangle, each of whose sides doth consist of a thousand miles) and yet there is a fourth place so situated in respect of the other three, that a man may travel on foot from it to any of the other three, in the space of one artificial day at a certain time of the year, and that without the least hurry or fatigue whatsoever.

New Questions.

I. Question 41, by Mr. Dod.

A rakish spark the other night,
 (Who had learn'd some algebra)
 Came home half drunk, as well he might,
 From tippling all the day.
 His uncle chid him, and complain'd,
 He'd run thro' his estate,
 And ask'd what he that day did spend;
 To which he answer'd streight,
 The pence squar'd and involv'd into
 Five times their own square root,
 Are pounds one hundred sixty-two,
 Whence you may find it out.

II. Question 42, by Mr. William Taylor.

As I was walking out one day,
 Which happ'ned on the first of may,
 As chance would have it, I did spy
 A may-pole raised up on high,
 The which at first me much surpriz'd,
 Not being before-hand advertiz'd

Of such a strange uncommon sight,
 I swore I would not stir that night,
 Nor rest content until I'd found
 Its height exact from off the ground:
 But when these words I just had spoke,
 A blast of wind the may-pole broke;
 Whose broken piece I found to be
 Exact in length yards sixty three;
 Which by its fall broke up a hole,
 Twice fifteen yards from off the pole;
 But this being all that I can do,
 The may-pole now being broke in two
 Unequal parts: To aid a friend,
 Ye ladies, pray an answer send.

III. *Question 43, by Mrs. Boydell.*

An aged sire, with his two daughters, came
 To town, and was desir'd to tell his name.
 My name, says he, 's a thousand more than you,
 And I. and if you add the other two,
 The number of this present year they'll shew.
 The * num'r'al letters of our names (well set
 With the first letter of the alphabet)
 Make seventeen hundred, and fourteen compleat.
 I'll further add (to make the problem plain)
 Each single name five letters doth contain.

* D. stands for 500, C. for 100, L. for 50, V. for 5, I. for 1, &c.

IV. *Question 44, by Mr. T. Hayward.*

Within my garden, lying on the ground,
 A stone I've got, that weighs 300 pound:
 A little barrow likewise, six foot long,
 I've got; tho' little, it is very strong.
 Now, sirs, because the stone lay in my way,
 I sold it to a mason yesterday;
 Who begg'd my barrow for to take it home,
 And call'd his two men; presently they come;
 But one (being lately sick) was very weak,
 More than five score he could not undertake.
 How on the barrow must this stone be laid?
 Pray tell me; for this fellow is afraid,
 If he should carry much, 'twould do him more
 Diskindness, than his sickness did before.

V. *Quest-*

V. *Question 45, by Mr. Tho. Shepheard.*

Suppose the earthly ball's circumference
 Be one and twenty thousand miles in length,
 Besides six hundred more. I fain would know
 How far the head of any one doth go
 More than his feet; (but yet I must display
 The matter more, or you'll not find the way.)
 One that's five foot and seven inches tall,
 To go in length upon this earthly ball
 Ten thousand miles exactly: That is all.

}

VI. *Question 46, by Mr. Ed. Elphick.*

Kind sir, I pray, can you to me declare
 A lofty tower's height within the air:
 I'll tell you how the height you well may know,
 Which in a problem unto you I'll show.

If from the tower's height there should be laid
 A plain, whose surface fine and smooth is made,
 To meet the earth; three hundred foot and four
 From the foundation of this lofty tower;
 And then a body which in pounds doth weigh
 Just fifty six, you on the plain do lay;
 Just forty pounds will the fame sustain,
 From sliding down on this descending plain.
 But, artist, I apply myself to you,
 (The tower's height) to calculate it true.

The Prize Question.

When Phœbus had up-heav'd his golden head,
 From the soft pillow of his sea-green bed,
 And with his rising glory had possess'd
 The spacious borders of th' enlighten'd east:

In Albion's channel, off from the cliffs of Dover,
 Where I could scan that famous channel over,
 And make bright Callis shining in the east,
 Our ship then lying almost pointing west;
 The day serene and fit for observation,
 I sent a ship to form a second station:
 Then I observ'd my angles for to be
 * Twenty four and eighty six degree;
 And at my second I the object sees,
 At † forty eight, a hundred twenty nine degrees.

* 24° and 86° . † 48° and 129° .

This

This being known, How far's each ship's from th' other?
Likewise, how far off Callis and off Dover?
But e'er the case determin'd will appear,
The following lines to you I must declare.

Being on Dover's beach an object I espy'd,
Which on a wave from Callis bank did glide.
In equal times it equal spaces run,
From whence its rapid motion first begun.

Forty five foot was each wave's true distance,
And in a line approaching me did dauce;

* Two hours, twenty five minutes, ten seconds more,
Ten thirds, thirty three fourths (the wave did roar)
And thirty six fifths, is the true time I found,
From my first sight to's breaking on the ground;
Which was the place I stood upon.

Now I would know how far the distance run.
Which being known (what undetermin'd were)
If rightly managed) true proportion bear.

* 2 h. 25' 10" 10" 33" 36".

1716.

Answers to the Paradoxes proposed last year.

Anna Philomathes answer'd them all. To the first thus :

FROM the place o'th' jews abode let the other two set out,
The christian east, the turk west, and sail the globe about,
Then with the jew they'll agree when they again do meet,
And all upon the saturday will their true sabbaths keep.

Paradox 2d answered, the South Pole.

Paradox 3d. If a burning glass be the nodus of a dial, and so contriv'd that the focus may fall on an iron or brass plate or ring, on which the figures are deeply cut, a blind man may feel where the plate or ring is heated by the sun, and which figure it is upon or nearest to.

To the 4th paradox the ingenious Anna Philomathes thus answers : The light that falls upon any body, being always in a reciprocal duplicate ratio of the distance from the luminous body : hence it follows, that not only in Ethiopia, but in all parts of the world the moon doth always appear to be most enlightned, at the full moon, when she's least enlightned, because she is then removed from the sun farther than at the new moon, by the diameter of the moon's orbit.

The

The 5th paradox answered, according to Euclid. A plane can touch a sphere only in one point, call'd the contact, and that person only who stands to that point (with respect to the center of that sphere) can stand upright.

The 6th paradox answer'd. By an artificial day is here meant from sun-rising to setting. And beyond the tropick, and nearer and nearer the poles, the days are increas'd when the sun comes on that side the equator from 24 hours long to about 100 days long, the sun neither rising nor setting in that space of time.

Mr. Moyle answer'd 2, 4, 5, 6; Mr. Edens, all; Pastora, the first. Mr. B. Graves, 1, 2, 5. Mr. Andrew, 2, 5, 6. John Hodge, all. Mr. Walker, 2, 6. Mr. Wylde, 2, 6. Mr. Coles, 1. Mr. Wentworth, 2, 6. Mr. Asb, 1. Tho. Andrew, 3, 6. Tho. Coach, 5, 6. I. Richards, 1, 2, 5. R. Hall, 1, 2. and Cynthia Aris, the first.

Solutions to the last year's questions.

* I. *Question 41, answered by Mr. Richard Sandford.*

Well might his uncle blame the rakish sot,
For spending thus three shillings at a shot;
Sure he'll no longer trifle time away,
But spend less in ale, more in algebra.

The same answer'd by Silvia.

Your algebraick, tipling spark,
Might well reel home, when in the dark;
I'll swear he was a learned blade,
And has a learned reck'ning made:
'Mongst pot companions he's no fool,
Who scores by scale, and drinks by rule;
But to prevent his uncle's loss,
I here explain the tippler's dose.

Ans. 36 pence.

If the pence in 162 pound be b , and the pence spent be $= a$; then this theorem solves the question $a = \sqrt[5]{\frac{b^2}{25}} = 36$.

II. *Ques-*

* I. *QUESTION 41. solved.*

Let x denote the pence spent. Then, by the question $x^2 \times 5 \sqrt{x} = 162 \times 240 = 38880$, or $x^2 \sqrt{x} = 7776$; hence, by squaring, $x^4 \times x$ or $x^5 = 7776^2$; and consequently $x = 7776^{\frac{2}{5}} = 36 d. = 3 s.$

* II. *Question 42d, answered by Mr. Jos. Jeacock.*

To aid a friend, I here intend,
 The may-pole's height to show,
 So if you please, you may with ease
 Thus view it here below. *Ans. 118' 3985 yards.*

This is found by the 47th theorem of 1 lib. Euclid.

III. *Question 43, answered by Philo Tipperus, and Mr. P. Profon.*

Whilst Lidia for Lydai you cunningly write,	
You think you may surely ensnare us;	<i>David</i> 1006
But David is aged, and Lucia bright,	<i>Lidia</i> 552
So 'tis easy to——Philo Tipperus	<i>Lucia</i> 156
The daughters who to town with David came,	
Lucia was one, and Lidia's t'other's name.	<i>P. Profon. 1714</i>

IV. *Question 44, answered by Silvia.*

To ease the mason's feeble man by true mechanick skill,
 The stone upon the barrow plan thus to be plac'd I will;
 Of gravity the center lay, just so much next the stronger,
 That distance 'twixt the other may be two to one the longer.

In questions of this nature the result will be; the greater strength multiply'd by the shorter length, is equal to the lesser strength multiply'd by the greatest length; and here the barrow's weight is not accounted for, otherwise it would require some skill in staticks to resolve it.

V. *Question 45, answered by Silvia.*

Your thought is odd, but just, the case is plain,
 Our heads in haste, outstrip our heels;
 And what in miles ten thousand thus they gain,
 (Unless the man be drunk or reels)
 Without the help of magick or a spell,
 In arithmetick numbers, I will tell.

'Tis

* II. *QUESTION 42. solved.*

It is evident, from the question, that the part broken off (63) is the hypotenuse of a right-angled triangle, whose perpendicular is the part left standing, and base equal to (30) the given distance which the top struck the ground from the pole; and consequently, by right-angled triangles, $\sqrt{63^2 - 30^2} = \sqrt{3069} = 55.3985559$ = the part left standing. To this adding 63 the part broken off, we obtain 118.3985559 for the whole length required.

'Tis evident in the case propos'd, that while the feet describe an arch on the earth's surface equal to 10000 miles, the head will describe a similar arch of a circle, whose radius exceeds the semi-diameter of the earth 5 feet 7 inches: Therefore as the semi-diameter of the earth, is to the semi-diameter increased by 5 feet 7 inches: So is 10000 geographical miles, to an arch exceeding 10000 miles by 16'23 feet, according to *Van Culen's* proportion of the diameter to the circumference, viz. as 1 to 3'141592653589793.*

VI. *The 46th Question answered by the same, and Mr. James Cole, Mr. Doidge, Mr. Edens, Mr. Willingham, Mr. Ronksley, Mr. Wylde, Anna Philomatha, Mr. Richards, Mr. Bower, &c.*

Your tower's lofty and sublime,
Your problem rational and fine,
Your method's just, I like the notion,
Which joins with numbers, weight, and motion;
But sure it is contriv'd to vex
Our uninstructed, softer sex:
You try our weakness, search out flaws,
By algebra and statick laws;
Yet to untie your curious knot,
Since 'tis a homely virgin's lot,
Please to accept my kind, officious aid,
Who am a rural and mechanic maid.

By a known principle in mechanicks, the accelerating velocity, or weight of bodies on an inclin'd plane, is to their accelerating velocities or weight in their perpendicular descent, as the sign of the angle of inclination, to the radius; or as the perpendicular to the length of the plane, consider'd as an hypotenuse; and therefore in this the proportion of
the

* V. QUESTION 45. *solved.*

Since the earth's radius is $\frac{21600}{2 \times 3'14159 \&c.}$ inches, and 5 feet 7 inches = 67 inches; by similar sectors, as radius : radius + 67 :: 10000 : 10000 + the excess travelled by the head; or, by division, as radius : 67 :: 10000 : the said excess; that is, as $\frac{21600}{2 \times 3'14159 \&c.}$: 67 :: 10000 : $\frac{10000 \times 67 \times 2 \times 3'14159 \&c.}{21600}$
= $\frac{6700 \times 3'14159 \&c.}{108}$ = 194'8951 inches = 16'2412 feet = the excess required.

Mathem.

M

the perpendicular, and the length of the plane, being given as 40 to 56, or as 1 to 1.4. Let the perp. sought be $= x$, the hypotenuse will be $1.4x$, and the base 304 feet $= a$, then, $1.96x^2 - x^2 = 0.96x^2 = a^2$ by 47 Euclid 7. and by division and evolution.

$$x = \frac{aa}{0.96}^{\frac{1}{2}} = 310.27 \text{ feet required.}^*$$

Here follows the answers of two ingenious persons to all the 6 questions, in one copy of verses.

Mr. C. Mason, from Northumberland.

The rakish spark three shillings spent, Quest. 41.

If that I took it right;

Which having done, he swagg'ring went,

And took the may-pole's height;

Which was in yards, fivescore eighteen, 42.

And nigh four-tenths, I say;

But David the like ne'er had seen, 43.

Lydia nor Lucia.

Then take one-third o'th' barrow's length, 44.

And thereon lay the weight,

'Cause the one exceeds a third in strength,

'Twill counterpoize them right:

Then sixteen feet one quarter more, 45.

Let them bear it away,

Or feet three hundred and ten, some o'er 46.

They there may let it stay.

Mr. Fran. Walker, of Lynn, in this method answer'd all
 six; as did Mr. Ambrose Gilbert, except the 46th question.
 I am

* VI. QUESTION 46. solved.

It is evident that this problem may be easily *Constructed* thus: Make a right-angled triangle whose hypotenuse and perpendicular are 56 and 40, or 7 and 5, or any two numbers proportional to these; then make another similar triangle whose base may be 304; and its perpendicular will be the height of the castle required.

And from the same principle, the *Calculation* may be given without algebra, thus: Since $\sqrt{7^2 - 5^2} = \sqrt{24}$ = the base of the first triangle to which the other is similar, we shall have as $\sqrt{24} : 5$
 $:: 304 : \frac{304 \times 5}{\sqrt{24}} = \frac{304}{\sqrt{.96}} = \frac{760}{\sqrt{6}} = 310.2687$ = the castle's height.

I am sorry no other persons that have truly answer'd them singly, would take the pains to put their answers into one short copy that might have had a place here.

*The Prize Question answered.**

To this question, besides abundance of false answers, I received ten true ones, and because I see so few amongst so many ingenious correspondents, I am apt to believe it was as difficult, as 'twas an uncommon question; for which reason I shall here give you the solution, and the algebraick method by which the same is found.

Sir *Isaac Newton*, in his *Principia*, says, Let there be a pendulum, whose length from the point of suspension, to the center of oscillation, is the breadth of any wave; then while the pendulum makes an oscillation, the wave will pass over a distance equal to its breadth. From which, and the nature of pendulums, is raised the following theorem.
Let

** The PRIZE QUESTION solved.*

Perhaps the solution will appear a little clearer thus: Put $p = 39\frac{1}{2}$ inches the length of the pendulum, $v = 60$ the number of vibrations it makes in a minute, $b = 45$ feet the breadth of a wave, and $t = 145\cdot1696$ minutes the given time. Then, by the nature of pendulums, $\sqrt{12b} : \sqrt{p} :: v : v\sqrt{\frac{p}{12b}}$ = the number of vibrations made in a minute by the pendulum whose length is the breadth of a wave; but for every vibration the wave will pass over a distance equal to its breadth b ; hence the wave moves over

$bv\sqrt{\frac{p}{12b}}$ or $v\sqrt{\frac{bp}{12}}$ feet in each min. which therefore drawn into

t minutes makes $tv\sqrt{\frac{bp}{12}} = tv\sqrt{\frac{45 \times 39\frac{1}{2}}{12}} = tv\sqrt{15 \times 9\cdot8} = 77v\sqrt{3} = 145\cdot1696 \times 420\sqrt{3} = 105605\cdot2$ feet = 20 miles nearly = the distance between Calais and Dover.

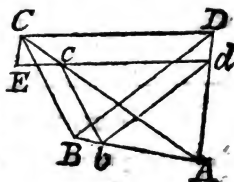
This distance being obtained, which is the side CD of a quadrilateral $ABCD$, of which the angles formed by the opposite side AB with the two diagonals BD , AC , as also with the other two sides AD , BC , being given, the figure will be *Constructed* (as in the British Oracle) thus:

At the extremities A, b , of any line Ab , make the angles bAc , bAd , Abc , Abd equal to the given angles, and join c, d ; so shall $Abcd$ evidently be a quadrilateral similar to that formed by the two towns and two ships; and, consequently, if dc be produced to E , till dE be equal to 20 the given distance between Calais and Dover,

Let the distance run be $= a$, the length of a standard pendulum $= p = 39\frac{1}{2}$ inches; the square of the vibrations in a minute $= f = 3600$, $s = 45$ feet or 540 inches, the breadth of the wave, and $t = 2$ hours 25 min. &c. $= 145\frac{1}{3}$ minutes, also $r = 45$ feet: then $s : p :: f : \frac{pf}{s}$; but $\sqrt{\frac{fp}{s}}$ = to the number of vibrations it will make in a minute, and multiplied by r will be the feet the wave will move in a minute; but $\frac{a}{r\sqrt{\frac{pf}{s}}} = t$, and consequently, by reduction, $a = r t \sqrt{\frac{pf}{s}} = 105600$ feet $= 20$ miles sought, or the distance from Calais to Dover.

In this following figure C represents Calais, D Dover, A the first ship, B the second.

Then
 From $\left\{ \begin{array}{l} \text{Cal. to Dov. } C \text{ to } D \text{ 20 mil.} \\ \text{Dov. to 1st sh. } BA \text{ 13}^{\circ}51'92'' \\ \text{Dov. to 2d sh. } DB \text{ 18}^{\circ}15'83'' \\ \text{Cal. to 1st sh. } CA \text{ 22}^{\circ}40'08'' \\ \text{Cal. to 2d sh. } CB \text{ 11}^{\circ}72'38'' \\ \text{1st sh. to 2d sh. } AB \text{ 13}^{\circ}08'53'' \end{array} \right.$



The angles $DAB \ 86^{\circ}$, $CAB \ 24^{\circ}$,
 $DBA \ 48^{\circ}$, $CBA \ 129^{\circ}$.

Mr. William Hawney, (who won the prize of 10 diaries)
 Mr. John Edens, A. Philomathes, Mr. James Mousse, Mr. Stephens,

and EC be drawn parallel to Ad and meeting Ac in C , that then CB , CD being drawn parallel to cb , cd , and meeting Ab , Ad in B and D , the points A , B will be the two ships, C Calais, and D Dover.

The Calculation from this construction is also evident: viz. assuming $Ab =$ any number, as suppose 10, in the two triangles Abc , Abd , we have given all the angles and the side Ab , to find the other sides; and hence those sides are $Ac = 17.11811$ miles, $bc = 8.95914$ miles, $Ad = 10.33093$ miles, and $bd = 13.86777$ miles. Then in the triangle bcd are given two sides with their included angle, to find the third side cd , which will be $= 15.28859$ miles. Lastly, by similar triangles, as $cd = 15.28859 : CD = 20$

$$\begin{array}{l} \left\{ \begin{array}{l} Ab = 10 : AB = 13^{\circ}08'165, \\ Ac = 17.11811 : AC = 22^{\circ}39'331, \\ Ad = 10.33093 : AD = 13^{\circ}51'456, \\ bc = 8.959144 : BC = 11^{\circ}72'004, \\ bd = 13.86777 : BD = 18^{\circ}74'133. \end{array} \right. \end{array}$$

Stephens, Mr. Stewart, T. W. Mr. James Pearse, and Mr. Cha. Bower answer'd this question, as also *Mrs. Mary Nelson* in the following verse:

Master Tar, I protest I'm not pleas'd with your query,
 You've sent at this time to be solv'd in your diary,
 Methinks it looks like an ill-natur'd demand,
 To offer to puzzle us ladies at land;
 Tho' I'm apt to believe, if a trial should be,
 That you'd puzzle us worse if you had us at sea:
 But methinks I can guess how you sparks are inclin'd,
 You are always best pleas'd when the ladies prove kind;
 Then to shew that we maids of this brave British nation,
 Can act here at land; or at sea on occasion,
 To each of your queries I've sent you an answer,
 And all of them right, then deny't if you can, Sir.
(Here follow'd the answer.)

Of the Perfection of Astronomy.

Having last year said a word or two of the mathematics in general, I shall here handle them gradually: but as astronomy is the most noble and sublime of all the parts, I shall at present confine myself to say something of it. In which let us consider, to what perfection we now know the courses, periods, orders, distances, and proportions of the heavenly bodies, at least such as fall within our view. We shall have cause to admire the sagacity and industry of the mathematicians, and the power of numbers and geometry well applied: if we cast our eyes backwards, and consider astronomy in its infancy, what a mean and inconsiderable figure did it make, to what it does in our days?

Let us suppose (saith an ingenious author) a colony of rude country people transplanted into an island, remote from the commerce of all mankind, without so much as the knowledge of the calendar, and the periods of the seasons; without instruments to make observations, or the least notion of them. When is it we could expect any of their posterity should arrive at the art of predicting an eclipse? Not only so, but the art of reckoning all eclipses that are past or to come, for any number of years? When is it we could suppose, that one of those islanders, transported to any place of the earth, should be able, by the inspection of the heavens, to find how much he were south or north, east or west of his own island, and to conduct his ship back thither? For my part, though I know this may be, and is daily done, by what is known in astronomy, yet when I consider the vast industry, sagacity, multitude of observations, and other intrinick things neces-

fary for such a sublime piece of knowledge, I should be apt to pronounce it impossible, and never to be hoped for.

Now we are let so much into the knowledge of the machine of the universe, and motion of its parts, by the rules of this science, perhaps the invention may seem easy. But when we reflect, what penetration and contrivance were necessary to lay the foundation of so great and extensive an art, we cannot but admire its first inventors: such as *Thales Milesius*, who predicted eclipses, and his scholar *Anaximander Anilesius*, who found out the globous figure of the earth, the equinoctial points, the obliquity of the ecliptick, the principles of gnomonics, and made the first sphere, or image of the heavens; and to *Pythagoras*, to whom we owe the discovery of the true system of the world, and the order of the planets: tho' it may be they were assisted by the Egyptians and Chaldeans. But whoever they were that first made these bold steps in this noble art, they deserve the praise and admiration of all future ages.

Altho' the industry of former ages had (as I said before) discovered the periods of the great bodies of the universe, and the true system and order of them, and their orbits pretty near; yet were they very deficient in divers things.

The one was in the true calculations of eclipses; for the best of them mistook egregiously in them, making eclipses when really there was none, and omitting them many times when the luminaries were really obscur'd; and when they with difficulty hit upon the time pretty near, they were often out in the digits eclipsed, and sometimes making one side of the sun or moon dark, when really it proved to be the other. But the astronomers of our age have arrived at much greater perfection, especially in the sun's eclipse (witness that great one last year) which is much more difficult than that of the moon; for an eclipse of the moon has the same appearance to all its beholders; whereas that of the sun may appear to one part of the earth totally eclipsed, to another part of the earth eclips'd but in part on its north side, to others eclips'd in part on its south side, and to others not eclips'd at all; and all this at the same moment of time. So that an eclipse of the sun must be calculated for every individual place, if you have its true appearance, which causes it to be so difficult to perform, and made the ancients to err so very much in that particular. As an instance of our modern improvements, I will give you the calculations of two great eclipses of the sun, which are the greatest that will happen in our island these 50 years yet to come, and tho' they happen not for several years, I doubt not but they that observe them, will find them exactly at the time here set down. They are calculated for the latitude of

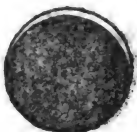
of 52 deg. 30 min. and longitude 1 deg. 30 min. West from London, being the city of Coventry. The first is on the 11th of May, 1724, the second on July 14, 1748, calculated from Mr. *Street's Astronomia Carolina*.

May 11, 1724, in the evening.

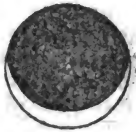
14 July, 1748, m.

	h.	m.	s.		h.	m.	s.
The apparent time of the true \odot	5	17	3		11	16	38
The interval of true and visible \odot	1	17	13	sub.	0	39	14
The visible \odot — — —	6	34	16		10	37	24
Interval of vis. \odot and greatest obf.	0	0	16	ad.	0	0	54
The beginning — — —	5	38	9		9	8	12
The middle — — —	6	34	0		10	38	18
The end — — —	7	26	25		12	12	30
The whole duration — —	1	48	16		3	14	18
Digits eclipsed — — So.	11	31	40	No.	10	16	13
Latitude of \odot at beginning	1'	45"	S. D.	7'	18"	N. D.	
Latitude of \odot at ending	2	11	S. D.	3	13	S. D.	

1724



1748



On February 18, 1737, happens a great eclipse, but less than either of these two, being eclipsed digits 10 d. 5 m. The middle at 46 min. after 3 in the afternoon.

Tho' the industry of the ancients was very great, and the improvements of the latter days very considerable, yet was there one thing still reserv'd for the glory of this age, and the honour of the English nation, the grand secret of the whole machine; which now it is discover'd; proves to be (like the other contrivances of infinite wisdom) simple and natural, depending upon the most known and most common property of matter, namely, gravity. From this the incomparable Sir *Isaac Newton* has demonstrated the theories of all the bodies of the solar system, of all the primary planets, and their satellites, and among others, the moon, which seem'd most averse to numbers, and the comets also, whose revolutions spend more than 2000 years about the sun. A wonderful discovery! scarce ever to be hoped for by the boldest thinker.

Observations on the great Eclipses.

The great solar eclipse on the 22d of april last year, being by so many hands calculated, and there appearing so great a difference in the time of the eclipse's happening, amongst those calculations; and seeing each one so fond of his tables, or of those he uses, thereby to lessen the esteem, if possible, ingenious men bear to the Caroline tables; I have endeavoured to get what observations of that eclipse I could, from several ingenious men, to prove which tables solved this phenomenon exactest. And forasmuch as the calculation in the ladies' diary last year was for London; tho' by mistake said to be for Coventry, I have taken the pains to calculate that famous eclipse again, and all along to compare it with what others have done, and do assure you, the result in the next side is the true calculation from the second edition of *Street's* tables. And that many others who calculated the same by those tables, have not come within 8, 10, or 12 min. of the true time, is occasioned, as I conceive, by mistaking that author as to the absolute equation of time, in page 83, making it about 3' 15" instead of 16' 23", differing above 13' in that particular. Nor do I find any who have calculated by Mr. *John Wing's Scientia Stellarum*, come near to observation unless himself, which, and that he did from Mr. *Shakerley's* tables, are the two best I have met with, except the great Dr. *Halley's*, and the indefatigable M. *Flamsteed's*.

But what is more observable, scarce any one of them make it total, tho' calculated for near the path of the moon's center, or come near the true digits eclipsed, besides those from the Caroline tables; for my part I could never find it otherwise than total, even in London.

And because nothing but good observation can help us to improve our future calculations, I have subjoin'd some as I receiv'd them, the 4th, 5th, 7th, 9th, 10th, 11th, and 12th, were communicated to me by my worthy friend the Rev. Mr. *Wright*, of Crew, in Cheshire, whose accurate observations and skill in the jovial stronomy will (I doubt not) much advance it. The first was sent me by my ingenious countryman Mr. *John Edens*, from Teneriffe, one of the Canary islands, taken on board, in the latitude 34° 20' N. longitude 13° 20' west from London. And lastly, because the eclipse of the moon the 31st of october, 1715, by mistake of the printer, had its type revers'd, I have again inserted a new calculation from *Astronomia Carolina*.

Obser-

Observations.	Begin. h. m.	Immer. h. m.	Emerf. h. m.	End h. m.
Canaries, by Mr. Edens	6 49	digits	ecl. 9	8 47
Dublin	7 47			9 51
Exeter, by Mr. Richards		8 52	8 56	
Chester, by Mr. Ward	7 57½			10 6½
Crew, in Cheshire, by the } Rev. Mr. Wright }	7 59	9 2½	9 4	10 9
Worcester		8 58½	9 2½	10 9½
Oxen		9 4½	9 8	10 14½
London	8 6½	9 9½	9 12½	10 20½
Wanstead, Essex, Mr Pounds	8 6½	9 9½	9 12½	10 20½
Upminster, by Mr. Derham	8 7½	9 11	9 14	10 21½
Ladfdown, in Kent, by the } Rev. Mr. Thornton }	8 7½	9 10½	9 13½	10 22
Feverham, by Mr. Gray	8 9	9 13½	9 14½	10 24½
Lydd, by Mr. Hawney	8 9	not	total	10 23

The calculation of the sun's eclipse, the 22d of april last.

	h. m. s.	
The apparent time of true \odot	9 26 21	} At Coventry, by <i>Astronomia Caro-</i> <i>lina</i> , in the morn- ing.
The visible \odot at — —	9 5 19	
The beginning — —	8 1 40	
The end — —	10 15 49	
The whole duration — —	2 14 8	
The digits eclipsed $12^{\circ} 8'$.		

The moon's eclipse on the 31st of october next, 1715, at London, happens the beginning 55 min. past 2 in the morning; greatest obscuration is at 15 min. past 4, the end 35 min. after 5, the whole duration 2 ho. 39 min. and digits eclipsed $7^{\circ} 36'$.

In this year, 1716, on the 11th day of april, the sun will be eclipsed about two in the morning, and therefore not visible; and on october the 4th invisible: of which eclipses, had I room to insert the calculations, they would be useless, excepting to the countries where visible.

*Paradoxes to be answer'd next year, from
an ingenious author.*

Par. 1. There is a considerable number of places lying within the torrid zone, in any of which, if a certain kind of sun-dial be duly erected, the shadow will go back several degrees upon the same, at a certain time of the year, and that twice every day for the space of divers weeks; yet no ways derogating from that miraculous returning of the shadow upon the dial of Ahaz, in the days of king Hezekiah.

Par. 2. There are two distinct places of the earth lying under the same meridian, whose difference of latitude is 60 degrees compleatly, and yet the true distance between those two places doth not really surpass 60 Italian miles.

Par. 3. There is a certain noted part of the earth, where the sun and moon [*ipso tempore plenilunii*] may both happen to rise at the same instant of time, and on the same point of the compass.

Par. 4, by Hesychia.

I have 12 times seen the biffextile, pray tell how that can be?
Since 12 times 4 make 48, and I'm but forty-three.

New Questions.

*R. Question 47, by Mr. John Edens, of Teneriffe, one of the
Canary islands.*

A little close that lies in moorish ground,
Is by the following sides encompass'd round;
A drain must be exactly three foot wide,
And into equal parts the close divide;
The length of which I very fain would know:
But here observe, it must be order'd so,
That as little of the surface of the plain
May be broke up as possibly you can.

Just twenty chains the longest side contains,
The next when measur'd is just fifteen chains:
The least side then in chains just six you'll see,
To prove your skill, you must explain to me
The just content each equal part must be.
That is, when from the whole you've took the drain,
I'd know how much o'th' land doth then remain.

II. Question

II. *Question 48, by Mr. Maffey.*

A wealthy knight in Lincolnshire resides,
 Whose fields are wash'd by the redundant tides
 Of Wytham's chrystal stream: his chiefeft care,
 Pomona like, is how to bleis the year
 With fruitful products, from the teeming tree:
 For none more vers'd in rustick cult than he.
 Oblong in form, extended from his house,
 He did a closure for his garden chose,
 With chosen walnut plants he set it round,
 At once to shade his walks and load the ground
 Succeeding summers with prolific heat
 Manur'd the infant trees, and made them great,
 That they expand their tow'ring heads in air,
 And store of barricaded kernels bear:
 September last the knight employ'd his man
 To get the nuts, and bring the kernels in.
 The man returns, and with mysterious phrase,
 Premeditated, to his master says,
 Sir, your commands I willingly obey'd,
 And as I wrought, this observation made,
 On ev'ry tree so many boughs are found
 As there are trees in all your garden round:
 Nine of these trees as many walnuts bear
 As upon all the trees there branches are:
 If that you multiply the sum by three,
 You in the product all your nuts may see. (2187)
 What, Sir, from this account I humbly crave,
 Is that you tell how many trees you have.
 The knight, unskill'd in such conceits as those,
 Took up the nuts; and smiling off he goes:
 But turning short again, says, Hark you Nat,
 Send Mr. ———'s correspondents that.

III. *Question 49, by Mr. Hawney.*

Come, artists, who to figures are inclin'd,
 And try your skill four numbers for to find:
 Which in progression arithmetic are;
 Whose common difference four does declare.
 If these four numbers you shall multiply
 Into one another continually,
 The product thence arising you will see
 The same as in the margin placed be. (176985)
 Pray then don't fail in answering my request,
 For till they out are found, I cannot rest.

IV. *Question*

IV. *Question 50, by Philomathes.*

That noble lady, stil'd the queen of hearts,
 To the ingenious a query starts,
 Her standish weigh'd on earth two pounds in troy,
 But on the castle's top, just seven miles high,
 She found its weight did there not prove the same:
 Now she would know what was its loss or gain.

V. *Question 51, by Tho. Fletcher.*

Show me how to find out such numbers three,
 That when subtracted ev'ry one shall be,
 From the cube of their sum, there may remain
 Three cubes: for I shall ne'er this problem gain.

VI. *Question 52, by Mr. Tho. Pointin.*

In ancient times, 'twas in the days of yore,
 When malt was taxed, there was none before:
 A malster met a gauger on the way,
 And in their conference he thus did say:
 I have a cistern that's exactly square;
 The length, breadth, and depth, all three equal are.
 Another too I have o'th' same quality,
 But less in each part inches forty-three:
 What both will hold, you in the margin see. (119'998 bush.)
 What hold they each? and their dimensions?
 Tell by your skill, and your inventions;
 Or put in ladies' diary your intentions.

The Prize Question.

* By Galilæo's heaven's high-climbing scale
 Four * moons we see, to travel by and sail
 This earthly globe about. Now I would know
 How th' optic tube these jovial moons does show.
 Which visible: how † situate they'll appear,
 † The seventh of october at ten this year.

* Jupiter's satellites. † In respect to the east or west side of ♃.
 † Anno. 1716, Oct. 7 day, 10 h. P. M.

1717.

Answers to the Paradoxes proposed last year.

T^O *par. 1.* Anna Philomathes *says*, Any where in the torrid zone where the lat. is less than the declination of the sun, and both towards the same pole, the sun comes twice to the same point of compass both forenoon and afternoon, and an equinoctial sun-dial placed horizontally, the shadow of the gnomon shall go back, plus minus, twice every day. But because the *par.* mentions a certain kind of dial, I suppose, it may be thus answer'd, by a plain equinoctial dial described on both sides of an horizontal plain with two gnomons, and near the tropic when the lat. and declin. are equal, before the sun comes to the mathematical horizon in the morning he will shine on the lower side of the plain, and the shadow of the gnomon will run westward, *ad infinitum*, and presently after 6 o'clock as he shines on the upper plain the shadow runs eastward till noon, and thence to 6 even. at which time the shadow on the lower plain will begin and run westward till sun-set. There may by concave and convex, and reflex dials, be other ways of solving this.

Par. 2. The two places are not meant on the superficies of the earth, as you may perceive by the word [of] (and not upon) so the places will be so near the center of the earth, as 2 lines supposed to come, one from (o) lat. the other from 60 lat. and to meet in the center, may approach within the distance of 60 Italian miles. *A. Philom. J. Pearce, J. Wylde, and R. Hall*, answer'd this.

Par. 3. Under the north pole, the sun and full moon both decreasing in south declination and lat. will rise in the equinoctial points at the same moment, and under the north pole there is no other point of compass than south. Answered by *A. Philom. R. Hall.*

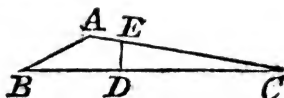
Par. 4. Anna Philomathes *answers thus*, If a person be born on 25 feb. and travel westwards the globe about, he may see 12 bissextile years before he be compleatly 44 years of age, if he be born in a bissextile year. *Mr. Moyle, R. Hall, Ob. Flower, and J. Pearce*, answered this paradox.

Solutions to the last year's questions.

I. The 47th question answer'd.

AB is 6 chains
 CA 15 chains
 CB 20 chains

} per quest.



The content is easily found to be 2 acres, 3 roods, 17 perch. and 45280 parts of a perch. The drain will cut off an isosceles triangle, whose two legs will be equal, represented by EC , CD . By the doctrine of fluxions, these two theorems for finding CD and DE will come out,

$$CD = \sqrt{\frac{a^2 b}{2}} = 269.4435 \text{ yards, and}$$

$$DE = \sqrt{\frac{2ab + c^2 - a^2 - b^2}{2}} = 51.59457 \text{ yards.}$$

Now 13837.97 yards the whole area — 51.59457 = 13786.37543 square yards after the drain is made.*

The

* I. QUESTION 47 solved.

By theorem 7 of *Simpson on The Maxima and Minima of Geometrical Quantities*, the required drain DE will cut off an isosceles triangle DCE ; and since it must cut off half the whole (or the middle of the drain, represented by DE , is supposed to cut off half the whole), and triangles which have one angle common being as the rectangles of their sides about the common angle, we shall have as

$$2 : 1 :: AC \times CB = 15 \times 20 : \frac{AC \times CB}{2} = 150 = EC \times CD = EC^2; \text{ and hence } EC = CD = \sqrt{150} = 12.2474487 \text{ chains.}$$

Now, by cor. 1 page 65 *Mensuration*, the triangle ABC is equal

$$\frac{1}{4} \sqrt{BC + CA)^2 - AB^2} \times AB^2 - BC - CA)^2 = \frac{1}{4} \sqrt{35^2 - 6^2 \times 6^2 - 5^2} = \frac{1}{4} \sqrt{41 \times 39 \times 11} = 28.590875 \text{ square chains} = 13837.9835 \text{ square yards.}$$

And, by the same, the triangle DCE is =

$$\frac{1}{4} \sqrt{DC + CE)^2 - DE^2} \times DE^2 = \frac{1}{4} \sqrt{4CD^2 - DE^2 \times DE^2} = (\text{by writing } 2AC \times CB \text{ for its equal } 4CD^2)$$

$$\frac{1}{4} \sqrt{2AC \times CB - DE^2 \times DE^2}.$$

But, by the question, this latter triangle is equal to half the former; wherefore

$$DE^2 \times$$

II. *The 48th question answered by Mr. Dod.*

The lovely landskip, owing to the art
 Of modern cult, improv'd in ev'ry part,
 I view'd, and with unspeakable delight
 Beheld the vernal walks; charm'd with the sight
 Of seven and twenty walnut trees around,
 Fertile, affording shade to th' walking ground,
 And nuts, delicious fruit! might I aspire,
 And once my wish obtain, I should desire
 My habitation near the pleasing scene
 That calms our ruffled thoughts, and makes us all serene.

A. Naughley,

$$\frac{DE^2 \times 2AC \times CB - DE^2}{AB^2 - \frac{BC - CA^2}{2}} \times \frac{BC + CA^2 - AB^2}{2} =$$

$$\text{But } \frac{BC + CA^2 - AB^2}{2} = 2AC \times CB - \frac{AB^2 - BC - CA^2}{2};$$

which being written for it in the last equation above, we have

$$\frac{DE^2 \times 2AC \times CB - DE^2}{AB^2 - \frac{BC - CA^2}{2}} = \frac{2AC \times CB - \frac{AB^2 - BC - CA^2}{2}}{2}$$

From this equation it is evident that

$$DE^2 \text{ is } = \frac{AB^2 - BC - CA^2}{2}, \text{ and hence, as in the orig. solution,}$$

$$DE = \sqrt{\frac{AB^2 - BC - CA^2}{2}} = \sqrt{\frac{6^2 - 5^2}{2}} = \sqrt{\frac{11}{2}} =$$

$\frac{1}{2}\sqrt{22} = 2.34520788 \text{ chains} = 51.59457336 \text{ yards} = \text{the length of the drain, or} = \text{its area since its breadth is one yard.} \text{--- (And this is a very curious and remarkable theorem.)}$

By subtracting this from the whole area, we have 13786.389 square yards for the content remaining.

O T H E R W I S E .

The above solution supposes the drain to be a parallelogram, and that the middle line of it, or the line bisecting its breadth, divides the whole field into two equal parts: but, strictly and mathematical, that is not the case; for, by the question, the parts on each side of the drain must be equal, and then the said middle line of the drain will divide the figure into unequal parts; as will thus appear.

N 2

Let

A. Naughtley, in conclusion of an answer in verse, shews this algebraical solution: Let a be = to number of trees, then aa will be the number of all the branches, and $aa \times 3 = 2187$ by the question. Therefore by division and evolution,

$$a = \sqrt[3]{\frac{2187}{3}} = 27 \text{ the number sought.}^*$$

III. *The 49th question answered by Mr. M. Moyle.*

Sir, fifteen, nineteen, twenty-three,
And twenty-seven your numbers be.

The same answered by Hesychia.

Fifteen and twenty-seven do, as it seems,
To the four numbers give the two extremes.

If the common difference be d , and the first number sought be equal to a , then $a \times a + d \times a + 2d \times a + 3d = a^4 + 6da^3 + 11d^2a^2 + 6d^3a = 176985$ per quest. Now
by

Let $DEFG$ represent the ditch, and HI the middle line. Through H draw dc parallel to BC and meeting DG , EF in d and e : Then will be formed the two little equal isosceles triangles dHD , eHE , which will be both constant and given, because the angle C and the breadth of the ditch are so; and, since the parallelograms eI , HG are equal, as also the trapezium AF and triangle CDG by the question, it is evident that HI must be drawn cutting off the isosceles triangle $CHI =$ to $\frac{1}{2}$ the $\triangle ABC - 2$ the $\triangle eHE =$ a given area; to do which needs no pointing out here.

The calculation from hence would bring out the lines a little different from those above.

* II. QUESTION 48 otherwise solved.

There is one condition too many contained in this question, and it is accordingly omitted in the original solution above. If that condition be used; making x the number of trees, then $x^2 =$ the number of branches; hence $3x^2$ will denote the number of nuts, and $9 : x^2 :: x : \frac{x^3}{9}$ which will also denote the number of nuts; wherefore $3x^2 = \frac{x^3}{9}$, and $x = 27$.

by converging series, the value of (a) will be found = 15 just. Therefore $a + d = 19$, $a + 2d = 23$, and $a + 3d = 27$; but $15 \times 19 \times 23 \times 27 = 176985$ as required.*

IV. *The 50th question answered by Mr. Fr. Walker.*

That noble lady's standish that weigh'd 2 pounds in troy, 47 grains did want when it was seven miles high.†

R. Beales. Xantippe, Chr. Mason, and Mr. Ronkefly, answered this philosophical question, 47 or 48 grains.

V. *The 51st question answered by Rob. Beales and Mr. Ber-riffe, and no other.*

For those cube numbers 3, so nicely to be
That when every one is subtracted,
From the cube of their sum, and yet to remain
Three cubes; has me almost distracted.

Thus $\frac{494424}{2352637}$, $\frac{472696}{2352637}$, and $\frac{448000}{2352637}$: Which taken severally from $\frac{512000}{2352637}$ the cube of their sum, leaves these
3 cubes,

* III. QUESTION 49 otherwise solved.

Let $x + 2$ and $x - 2$ denote the two means, and $x + 6$ and $x - 6$ the two extremes; then, by the question, $x + 2 \times x - 2 \times x + 6 \times x - 6 = x^2 - 4 \times x^2 - 36 = x^4 - 40x^2 + 144 = 176985$; or, completing the square, $x^4 - 40x^2 + 400 = 177241$; the root of this is $x^2 - 20 = 421$, or $x^2 = 441$, and hence $x = 21$. Whence, the numbers are 15, 19, 23, 27..

† IV. QUESTION 50 solved.

Since the gravitation or weight of a body above the earth, is inversely as the square of its distance from the earth's center; if the earth's radius be supposed equal to 3993 miles, we shall have

$4000^2 : 3993^2 :: 2 \text{ lb.} : \text{the weight at 7 miles high; hence}$
 $4000^2 : 4000^2 - 3993^2 :: 2 \text{ lb.} : \text{the diminution,}$

Or $4000^2 : 7993 \times 7 :: 2 \text{ lb.} : \frac{7993 \times 7}{8000000} = .006993875 \text{ lb.} =$
 $36.28472 \text{ grains} = \text{the weight lost, or the decrease of gravity at that height.}$

3 cubes, $\frac{17176}{2352637}$, $\frac{39304}{2352637}$, and $\frac{64000}{2352637}$; whose roots are $\frac{26}{133}$, $\frac{34}{133}$, and $\frac{40}{133}$.*

W. Beriffe.

VI. The

* V. QUESTION 51 solved.

This is question 19 *Lib. 5 of Diophantus*, and is one of the most difficult in his book; the numbers in answer are brought out by his commentator *Bachet*. Our countryman *Kersey* and several others have solved this problem, and brought out other numbers answering the conditions. The various methods of solution are much the same as to the essential principles; but we shall give one nearly in substance according to *Schooten*, which seems to be as clear as any, who says he learned it by reading *van Collen's* letters, and who thought so highly of his solution, that he subscribed it with, *Cujus rei soli Deo debetur gloria*.

By putting for the sum of the numbers required $4n$, whose cube is $64n^3$; and $63n^3$, $56n^3$, and $37n^3$, for the numbers themselves; each of which being taken from $64n^3$, there remain n^3 , $8n^3$, and $27n^3$, three cube numbers as there ought. But also the sum of the numbers $156n^3$ ought to be $= 4n$; hence $39n^2 = 1$; and, to get n , the coefficient 39, ought to be a square.

To find numbers therefore, so that the said coefficient may be a square, let the sum of the numbers be 4, and two of the remaining cubes let be $n - 1$, and $4 - n$; each of these cubes being taken from 64 the cube of the sum, there remain $65 - 3n + 3n^2 - n^3$, and $48n - 12n^2 + n^3$ for two of the numbers; whose sum is $65 + 45n - 9n^2$; to make the first term of this a square by adding to it the third number, which must also be the difference between the cube 64 and the 3d remaining cube, it appears that the said 3d cube must be 8; for then $64 - 8 = 56 =$ the 3d number; which added to the sum of the two former numbers, we have the sum of all the three $= 121 + 45n - 9n^2$. To make this a square, suppose it $= 11 + n$, hence $n = \frac{23}{10}$; which

substituted in the above values of the numbers, they become $\frac{61803}{1000}$, $\frac{59087}{1000}$, and 56; or rather these are proportional to the numbers sought.

But we have not yet provided for the equality between the sum of these numbers and the assumed sum; wherefore, to include that condition, let $4z$ be the sum of the numbers, and the numbers themselves $\frac{61803}{1000}z^3$, $\frac{59087}{1000}z^3$, and $56z^3$; the sum of these is

$\frac{17689}{1000}z^3 = 4z$; hence $\frac{17689}{1000}z^2 = 1$, and $z = \frac{20}{133}$. Which

substituted.

* VI. *The 52d question answered by Mr. Ed. Moore.*

I've here agreed, in time of need;
 At once to make two friends;
 If gauger's eas'd, and malster's pleas'd,
 I'll look for no amends.

The side of the biggest cistern 62'9999314825 inches.

The side of the lesser — 19'9999314825 inches.

The biggest 116'2793 bushels. Lesser 3'7187 bushels.

A. Philomath.

Which may be found thus: Let 43 = difference of the sides, be = d , and the side of the greater = a , the side of the lesser shall be = $a - d$, and the sum of their cubes = $2aaa - 3da^2 + 3d^2a - d^3 = 119'998 \text{ bush.} \times 2150'42$, the solid inches in a Winchester bushel = 258046'099 inches, and the value of a will be found = 63 proxime; consequently

$a - d = 20$ inches. Then $\frac{633}{2150'42} = 116'278 \text{ bush.}$ and $\frac{20^3}{2150'42} = 3'720 \text{ bushels,}$ but their sum = 119'998 required.

A. Naughley, W. Whitworth, T. Coock, R. Phillips, Xantippe, J. Wylde, John Smith of Hoppesford in Warwickshire, J. Canning, W. Beriffe, J. Pearce, J. Symmonds, C. Mason, J. Stocks, W. Jaehling, T. Court, W. Rankeley, and W. Crabb, answered this question.

The

substituted for it in the above assumed values of the numbers, we have $\frac{494424}{2352637}$, $\frac{472606}{2352637}$, and $\frac{448000}{2352637}$ for the 3 numb. required.

And these answer all the conditions; for their sum is $\frac{1415120}{2352637} =$

$\frac{8}{133} = 4z$; and the cube of this sum diminished by the three num-

bers themselves leave $\frac{17576}{2352637}$, $\frac{39304}{2352637}$, and $\frac{64000}{2352637}$; which

are three cube numbers, whose roots are respectively $\frac{26}{133}$, $\frac{34}{133}$,

and $\frac{40}{133}$.

* VI. QUESTION 52 solved.

This question may be otherwise more simply solved thus: Let z denote the half sum of the sides of the cubes, and $d = 21\frac{1}{2}$ the half difference; then will the sides themselves be $z + d$ and $z - d$; and the sum of their cubes is $2z^3 + 6d^2z = 119'998 \times 2150'42$ (the inches in a bushel), or $z^3 + 1386\frac{1}{4}z = 59'999 \times 2150'42$. Hence $z = 41\frac{1}{2}$ nearly; and consequently the sides = 63 and 20.

The Prize Question answered by Mr. T. Wright, A. B. of Hart-Hall, Oxon. and who won the prize of 10 diaries.

I'll tell exact how Jove's four moons appear,
On october the seventh, at ten this year. 1716.

As for the first but little can be said,
For he's at midnight rest within the shade.
The third, will from his master nigh be run.
Its greatest distance towards the setting sun.
Likewise the second, will on the same side be,
Toward the third, from Jove two parts in three,
The fourth is nearest, in the east you'll see.* }

To this difficult question I received but another true answer, viz. by Mr. Ronkesley, of Hodroyd, by Wakefield, in Com. Eborac. This part of astronomy is what but very few have the happiness of seeing; it requiring a telescope of a considerable length to reach the satellites of Jupiter.

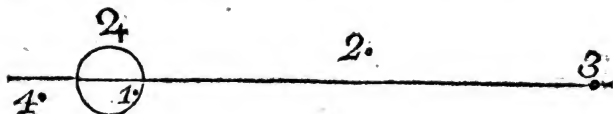
Mr. Ronkesley's answer.

The first immerg'd, on's east the fourth you'll see,
The third and second, on the west will be.

Ans.

* PRIZE QUESTION answered.

It is evident that the difference between the geocentric place of Jupiter and the place of each of his satellites, for the given time, will give their distances from him in signs, degrees, &c. which may be turned into semidiameters of Jupiter. To do all which is fully taught in most books of astronomical tables. These calculations made for the proposed time will give the distances in semidiameters and tenths of Jupiter thus; viz. 1st satellite = 0.8 W. the 2d sat. = 7.9 W. the 3d sat. = 15.0 W. and the 4th sat. = 2.2 E. Which being drawn from a scale of equal parts will appear thus



Where the configurations are adapted to the explanation given in the Nautical Almanac.

An account of Eclipses to be published.

In this place I design'd to have given an account of some more of the visible eclipses of the sun, as I did in my last, having them already calculated; but finding mine to agree so near to Dr. *Halley's*, both of that great one past 22d april, 1715, and that yet to come in 1724, whose calculations I take to be grounded on the best hypothesis yet discover'd, improved by the most accurate observations. I design to publish in a sheet, engraved and printed, all the visible eclipses of the sun that will happen before the year 1763, with their beginnings, middle, and endings, with exact types shewing the parts and digits eclipsed, their durations, and moon's latitude at the beginning, middle, and end of each, exactly calculated by *Astronomia Carolina*, for the meridian of Coventry, near the middle of England: of which timely notice will be given in the public papers. And here I am glad of an opportunity of doing justice to my industrious and indefatigable countryman Mr. *John Chattock*, late of Castle Bromwich, in Warwickshire, by letting the world know I have all along compared mine with his calculations (done from *Wing's Scientiæ Stellarum*) in manuscript now in my hands, whose ability in these sciences, the two excellent almanacs he published in 1708 and 1710 manifest. Whoever considers the care and pains that attend such calculations, will readily excuse some small errors that possibly may escape; such shall on notice be corrected in the ensuing diaries.

Here follow some observation of the moon's eclipse past october 1715, and some of the immersions and emersions of Jupiter's satellites, whose uses in finding longitude have long been approved, and others made of this kind will be gratefully received by the author from such as are so much friends to this noble science as to communicate them.

The moon's eclipse 31st october, 1715, in the morning, I observed at Newnham, in Warwickshire, lat. $52^{\circ} 32'$, long. 5 minutes in time after London, by a large quadrant and rectified pendulum; at the middle of this eclipse a line drawn by the two extremities of the horns of the enlightened part of the moon, made an angle with the horizon towards the south of 54 degrees, in which line 5 degrees distant above was Jupiter, and perpendicular over the moon 11 degrees distant the Pleiades, her altitude being then $27^{\circ} 26'$ the hour 4 h. 15 m. at 4 h. 45 m. 6 digits eclipsed; and moon's horns perpendicular at 5 h. 2 m. and dig. $3\frac{1}{2}$; 15 minutes before the end the 2 horns made a north angle with the horizon of 84° : the eclipse ended in the moon's limb diametrically opposite

142 LADIES' DIARIES. [*Beighton.*] 1717.
 posite to the river Palus Mæotis, at the altitude of $16^{\circ} 30'$,
 and the hour 5 and 34 minutes.

At Crew, in Cheshire, it was observed, as well as the
 foggy air would permit, as follows.

				<i>Crew - Newnh.</i>			
				h.	m.	h.	m.
The beginning or penumbra	—	—	—	2	36	2	50
Ætna immersed at	—	—	—	3	1 $\frac{1}{2}$		
Besbieus immersed at	—	—	—	3	15 $\frac{1}{2}$		
North part of Mæotis immersed	—	—	—	3	33 $\frac{1}{2}$		
South part of Mæotis immersed	—	—	—	3	41		
The middle about 8 digits eclipsed	—	—	—			4	15
Palus Mæotis emerged at	—	—	—	4	30		
The end at	—	—	—	5	24 $\frac{1}{2}$	5	34
The whole duration	—	—	—	2	48 $\frac{1}{2}$	2	44

By the same person, and at the same place, was the emer-
 sions and immerfions of Jupiter's satellites observed, as oft as
 the air would permit that season.

1715.				d.	h.	m.	s.		d.	h.	m.	s.	
24	1	Sat. im. sep.	26	8	59	15		2	Sat. emer. dec.	29	5	4	10
2		Sat. im. oct.	8	8	55	30		1	Em. dec.	29	6	8	50
3		Sat. em. nov.	28	16	1	20		2	Sat. em. mar.	9	7	33	19
3		Sat. em. dec.	27	7	52	45		1	Sat. em. mar.	14	8	51	55

Apparent time.

By several observations, the times precede those of the
 calculations by the tables, by about 7 or 8 minutes. The
 regularity of which errors proves the observations the more
 accurate.

This year last past has produced several uncommon ap-
 pearances in the air, as that unaccountable phenomenon
 on the 6th March, 1716, the halo's oft' seen, and heavenly
 bodies visible at noon, and according to this verse drew
 men's eyes upwards.

Os homini sublime dedit: cælumque tueri
 Jussit, & erectos ad sidera tollere vultus.

Ovid.

The eclipses of this year 1717.

There will happen in this year, 1717, four eclipses, two
 of each luminary: The first is one of the moon, on the 16th
 day of march, when the earth will interpose between the sun
 and moon, and hinder the sun's enlightning her, on her up-
 per (or north) part above one half of her diameter appear-
 ing dark. The calculation I have deduced from the Caroline
 tables.

The

h. m. s.

The mean opposition march 15th day, 1717	—	20 50 29
Interval of the mean and middle 8 subtract	—	6 4 43
The middle or equal time of the opposition	—	14 45 46
At which time the sun's place is in Aries	— d.	6 17 55
And the moon in Libra	—	6 16 47
Difference from the opposition want	—	1 8
Hourly motion of ☉ 2' 28", of ♃ 33' 14" differ.	—	30 46
As 30' 46" to diff. 1' 8" :: 60 to the interval add	—	2 13
The middle time of the true 8 15° day	—	14 47 58
At which time ☉ is in ♈	—	fig. 0 6 18 55
And the moon in Libra	—	fig. 6 6 18 46
The 8 subtract by ♃'s place	—	fig. 6 13 43 1
Remains the argument of latitude	—	7 24 15
♃'s lat. 39' 6" nor. ascending reduction subtr.	—	1 41
Hourly motion of ♃ 33' 55", of ☉ 2' 28" diff.	—	31 27
As 31' 27" to red. 1' 41" :: 60' to the ti. of ris. sub.	—	3 12
The equal time of the true ecliptic 8	—	14 44 47
Equation of time add	—	10
The apparent time of the true 8 at London	—	14 54 47
The ☉'s horizontal parallax 15", ♃'s 56' 56" sum	—	57 11
Subtract 15' 56" semid. ☉ rems semid. ☉'s shad.	—	41 15
To which add semid. ♃ 15' 24" the sum is	—	56 39
Latitude of the ♃ subtract	—	39 6
Remains the parts deficient	—	17 33
As 15' 24" to 6 digits :: 17' 33" to the digits ecl.	—	6 50 0
Reduct. or interval of greatest obscuration add	—	6 22
To the appar. times gives the greatest obscur. at	—	15 1 9
As 31' 27" to 60' :: min. of incidence 41' to }	—	1 18 13
half duration* — — — — }	—	

Hence

* This eclipse of march 15th, was observed as follows.

Places	Observers	Beginn.	End	Digits eclip.
Lima in Peru	D. Peter Peralta	h. m. s. 8 4 8	h. m. s. 11 19 55	
Cambridge, New England }	Mr. Robie	9 about	11 42 30	
The Island of Virgin Gorda }	Capt. Chandler		12 30 0	
St Cosma in South America }	F. Bon. Suarez	10 2 21	12 45 40	7 ³ / ₅
Paris — — —	Mr. Cassini	13 55 0	16 38 25	7 ¹ / ₂
Paris — — —	Mr. de la Hire	13 54 0	16 38 10	7 ¹ / ₃

Hence the eclipse march, 16°, 1717.

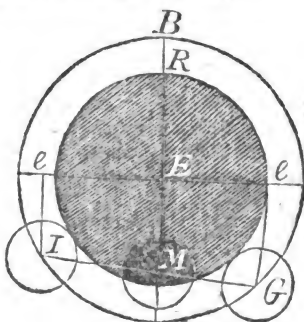
The beginning 42 min. 48 seconds past I. in the morning.

The middle 1 min. past III. in the morning.

The end 19 min. 14 seconds after IV. in the morning.

*A type of the moon's eclipse
the 16th of march, at 3
in the morning.*

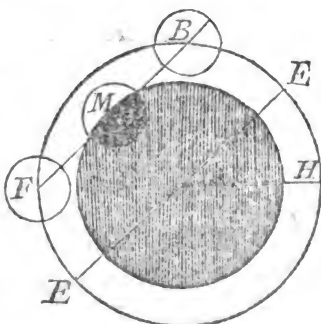
	m.	s.
Semidia. of shad. ER	41	15
Initial lat. of $\mathcal{D} eG$	41	37
Medial — EM	39	6
Final lat. $\mathcal{D} — eI$	33	59
Semidiam. of $\mathcal{D} RB$	15	24
G the \mathcal{D} at begin. Mat midd.		
I at end, eEe the ecliptic.		



The second is of the sun, 31st of march, at 19 minutes past 4 in the evening; but although the moon be but $70^{\circ} 46'$ from the south node, and near 4° within the eclipsing bounds, yet her lat. being then $4'$ south, and the sun's declination about $8^{\circ} 2'$ north, hinders the moon's shade falling near us, and therefore called invisible to any of the northern parts.

The third is of the moon on monday the 9th of september, at 6 in the evening, when 7 digits 26 minutes of the moon's diameter will be darkened on her lower or south part of her disk. So much as room will permit of the calculation follows.

Sept. 9 th , 1717. Eve. h.	m.	s.
The corr. eclips.	8	6 13 20
Appar. time Lond.	6	4 40
Beginning aftern. IV	46	58
Mid. vel max. obsf. VI	11	3
End — — VII	35	8
Whole duration	II	48 10
Digits eclipsed	7	26 40
Moon's lat. at beg. EB	40	25
At end, also } nor. def. }	EE	32 29



This figure shews exactly the appearance of this eclipse; B shews the moon where it begins, M at the middle, and E at

at the end, *EE* is the ecliptic, *EMB* the moon's way, and *FH* is the horizontal line in the eclipse.*

The fourth is an eclipse of the sun on monday the 23d of september, at 9 minutes past 7 in the evening; but the moon's lat. being $1^{\circ} 17'$ north, and the sun's decl. $4^{\circ} 40'$ south, the shade would not fall near us, tho' the sun was not set.

Paradoxes to be answer'd next year.

1. There's a certain village in the south of Great Britain, to whose inhabitants the body of the sun is less visible about the winter solstice, than to those who reside upon the island of Iceland.

2. There's a certain place of the earth, of a considerable northern latitude, where, tho' the days and nights (even when shortest) do consist of several hours; yet in that place it is mid-day or noon every quarter of an hour.

3. There are divers places on the globe of the earth, where the sun and moon, yea, and all the planets, do actually rise and set according to their various motions; but never any of the fixed stars.

4. There is a certain city in the southern part of China, whose inhabitants (both male and female) do observe almost the same posture and gait in walking as we Europeans; and yet they frequently appear to strangers, as if they walked on their heads.

Twenty-four of those amazing paradoxes in *Gordon's Geography* have been inserted in the ladies' diary; twenty of which are in it already, explain'd; 10 in time the whole forty-five will be solv'd.

A

* The eclipse of Sept. 9 P. M. was observed thus,

Places	Observers	End
London —	Royal Society —	7h. 27m.
Paris — —	M. Cassini — —	7 34 50s.
Paris — —	M. de la Hire —	7 34 15
Paris — —	M. Miraldi —	7 35 30
Norimburg	M. Wurtzelbaur	8 10 45

On monday June 10th this year, Dr. Halley discovered a small telescopic Comet; whose place at 11 o'clock that evening was $7^{\circ} 17' 12''$ with $4^{\circ} 12'$ south latitude.

Mathem.

O

A Philosophical Question, by A. Philomathes.

A golden ball shall weigh two pounds in troy,
 Where from th' equator ten degrees does lie;
 But at London, a diff'rent weight is found
 Of that same ball: which difference pray expound.

*New Questions.**I. Question 53, by Mr. Tho. Dod.*

A fortunate merchant got riches good store,
 And had jewels so many, you'd ne'er desire more:
 But the way to secure them, he cover'd them over
 With cloth for his buttons, so none cou'd discover
 The worth of his coat, he had on his back;
 Which above a pistole you'd ha' sworn ne'er wou'd take:
 So by this means he carry'd it safe; and 'twas sold
 After such an odd way as you never heard told.
 Some jewellers then that were ready to doat
 On the buttons, did join for to buy the rich coat;
 And agreed in proportion geometrical
 Thus to pay for the coat by the buttons, which all
 Were no more than sixteen; and a penny was paid
 For the first button only: the last, as they said,
 To this number of pence*, sir, you see, did amount:
 So they ask'd me to try with my pen, and to count
 What the sum was in pounds, shillings, pence, which it cost;
 But by trying, I found myself presently lost:
 For I wanted to know how the ratio increas'd;
 Which, if you will shew, I'll be very much pleas'd:
 Or, I'll thank you to tell me but what the coat cost,
 In a line to your servant, sir, by the next post.

* 14348907 pence.

II. Question 54, by Mr. Rob. Beales, of Lynn.

If London from Norwich be miles ninety-nine,
 And from those two cities two footmen design,
 The first to go three miles the first day from London,
 The second day five miles; next seven, and so on
 Towards Norwich, from whence the second one must
 The same time go for London to meet with the first;
 Whose first day's journey exactly is fix'd
 To be of the days they'll meet on, the sixth:
 His second day's journey does also agree
 To exceed the first in miles just by three,
 So each day's journey in excess must be.

}
 From

From this I would know, how you'll discover
 The days they'll be going till they meet one another:
 And how many miles then each will have gone,
 Is what I request you'll be pleas'd to get done.

III. *Question 55, by Xantippe, of Helmsley, Yorkshire.*

Once, as I walk'd upon the banks of Rye,
 To see the purling streams glide gently by,
 And hear the pretty birds to chirp and sing,
 Making the groves with melody to ring;
 I in the meads three beauteous nymphs did spy,
 Who there for pleasure came as well as I;
 And unto me their steps they did direct;
 Saluting me with most benign respect:
 Saying, 'Well met: we've bus'ness to impart,
 'Which we cannot decide without your art,
 'Our grannum's dead, and left a legacy,
 'Which is to be divided 'mongst us three.
 'In pounds it is two hundred twenty-nine,
 'And a good mark, it being sterling coin.'
 Then spake the eldest of the lovely three,
 'I'll tell you how it must divided be;
 'Likewise our names I unto you will tell;
 'Me they call Moll, my sisters Anne and Nell:
 'As oft as I five, and five-ninths do take,
 'Four and three sev'nths Anne takes, her part to make;
 'As oft as Anne four and one-ninth does tell,
 'Three and two-thirds must be took up by Nell.

IV. *Question 56, by Mr. W. Beriffe, of St. Ives.*

Ingenious algebraist, I fain wou'd know
 An answer to this question here below.
 A friend of mine ask'd me the other day,
 A little spot of land for to survey,
 That lay in form of a tripezia,
 I soon comply'd with his request, and found
 Three acres, wanting sixteen poles, of ground;
 The sides in chains here you may plainly see;
 The first was four, the second just twice three;
 Seven was the third; and for the fourth thus reckon'd,
 It being just the half of first and second.
 No parallel sides to you I must declare,
 Nor angle right will be admitted here.
 Ye sons of art, I do request you all
 To give a cannon algebraical,
 To find the length of the diagonal.

But one word more, lest you be overseen;
It is the longest which I here do mean.

V. *Question 57, by J. Symmons.*

Dick Dibble is almost out of his senses,
And begs me to be his amanuensis
To th' ladies, that in their next diary
They'll please to answer a gard'ner's query:
For orders lately from his master came,
That puzzle poor Dibble: altho' the same
To many others wou'd plain enough speak:
Dick says, the most on't is mere heathen greek.
A workman from him some directions must take,
About some dials that he is to make:
But he or the t'other can nothing effect,
Except the fair ladies, in pity, direct.
His master's first words to Dibble confound;
Degrees fifty-two, fifty minutes is found
The latitude, in the midst of the ground. }
There on the plane a streight staff you must fix
At right angles; on whose top, or apex,
Fourscore inches high, a small knob or ball.
March the second, mark how the shadow doth fall
From the foot of the staff, just on a south sun.
The 11th of june the same must be done,
When the sun is due west. These lengths being got,
Are half the diameters of the grafs plot:
Which is an ellipsis or oval to be,
The area, in inches, divide into three;
Two-thirds of that sum the mason must take,
For a stone step that he is to make
Of elliptical form, and five inches deep:
Whose length and breadth equidistant must keep
From the verge o'th' other great one of grafs;
On the step four lions couchant of brass,
Supporting a cube: which serves as a base
To a dodecaedron; and that bears a sphere. }
These solid bodies this proportion must bear
Of six, three, and one, exactly (or near)
The area's third, these bodies must have.
Now ladies, Richard most humbly does crave,
What the sides of the cube and dodecaedron are?
And what is the axis also of the sphere?

VI. *Question 58, by the Lady Mer. Heyshot.*

Two sons I have, comfort to me impart,
 And when in view, they do rejoice my heart.
 How old they be, is all I fain would know,
 Supposing true what here I state below.
 The age of one being squar'd, if from 't you take
 The younger's age, the residue will make
 As this (425): then square the younger's age,
 From which deduct the elder's, and I'll engage,
 The residue two hundred thirty-five you'll find.
 Their age to tell, pray ladies, be so kind.
 This I forgot: if to fifteen squar'd you add
 A hundred, their ages' product may be had.

The Prize Question, of 10 diaries to the answerer.

Upon a horizontal plane there stood
 A handsome tetrahedron, very good;
 I lik'd it well, and well the same I view'd,
 And found five solid feet its crassitude:
 Beside it stood a prism triangular,
 Whose height and side at base both equal are;
 Its content thirty-six ale gallons good,
 But being bottomless, while so it stood,
 To put in liquor none there venture wou'd.
 At last I fix'd the prisma very tight
 Upon the tetrahedron that was by't;
 This done, said I, see by this piece of skill,
 With ale or beer, the vessel ye may fill.

I ask the gaugers now, how much they think
 There's in the cask, of ale or other drink?
 In answer to the query, pray unfold,
 How much at once the cask so plac'd can hold:
 And also tell, how much th' elevation
 O'th' prisma is above its former station:
 But to prevent mistakes i'th' gauging part,
 Know, that a pyramid well wrought by art
 Triangular, the mouth close down did stop,
 Whose point just touch'd the tetrahedron's top.
 I've said enough, by which the artists know
 The answer of the query how to show.

1718.

Answers to the Paradoxes proposed last year.

Par. 1. **M**R. *R. Budgen* says the village lies under a high mountain near *Lewis*, in *Suffex*; that about the winter solstice the sun is but a very small space of time visible to the inhabitants.

Par. 2. Under the north pole.

Par. 3. Under the poles the planets by their motions get north or south declination, consequently rise and set with relation to those two places: but the fix'd stars keeping an exact distance from the pole, may be said *never* to rise, or set, tho' their motion on the poles of the ecliptic may be thought some small objection to this paradox.

Par. 4. In *China*, (or any other place) where the inhabitants stand near the sea, strangers looking in it must see them, as tho' their heads were downward by the reflected vision.

An answer to the philosophical question.

Mr. John Wilkinfon says, the proportion of gravity betwixt the equator and poles, is as 500 to 501, by the incomparable *Sir Isaac Newton*; and the increase near as the square of the right sine of the latitude; and that the ball would weigh more at *London* than at 10 deg. lat. by 13 grains.

This is, I presume, occasioned from the earth's oblate figure, and the diminution of the centrifugal force.

Mr. Doidge, *Mr. White*, *Mr. Bleathman*, *Mr. E. Weaver*, and *Mr. R. Hall*, answer'd the 2d and 3d paradoxes.

Mr. Whitworth 2d, 3d, and 4th, *Mr. Langley* 2d, *Mr. Mason* 3d, *Mr. Budgen* 1st and 3d, *Mr. Child* 2d and 4th.

Solutions to the last year's questions.

I. Question 53 answered by Mr. J. Peirce.

$\sqrt[15]{14348907} = 3$ the ratio. Let p be = first term = 1, s = second term = 3, u = last = 14348907, and z = sum of all the terms. Now $z - u$ = sum of all the antecedents; $z - p$ = sum of all the consequents. Therefore $p : s :: z - u : z - p$; and by equality $pz - pp = sz - su$; by transposition, and division, $z = \frac{3u - 1}{2} = 21523360$ pence = 89680 *l.* 13 *s.* 4 *d.*

* II. Question 54 answered by R. Hall.

Their journey went to six days,
Before they met each other;
The Londoner he went so fast,
Three miles out-strid the other. 51 and 48.

III. Question

* II. QUESTION 54 solved.

Putting x for the number of days they travelled, or the number of terms in each series, of which the two common differences are 2 and three; the corresponding first terms will be 3 and $\frac{1}{2}x$,

$$\text{the last terms} = \left\{ \begin{array}{l} 2. \frac{x-1}{3} + 3 = 2x + 1 \\ 3. \frac{x-1}{2} + \frac{1}{2}x = 3\frac{1}{2}x - 3, \end{array} \right.$$

$$\text{the sums of each pair of extremes} = \left\{ \begin{array}{l} 2x + 4 \\ 3\frac{1}{2}x - 3, \end{array} \right.$$

$$\text{and the sum of each series, or the miles each travelled} = \left\{ \begin{array}{l} x^2 + 2x \\ \frac{5}{2}x^2 - \frac{1}{2}x. \end{array} \right.$$

Then by taking the sum of these two sums, we have $\frac{3}{2}x^2 + \frac{1}{2}x = 99$; and hence $x = 6$ = the number of days, and $\left\{ \begin{array}{l} x^2 + 2x = 48 \\ \frac{5}{2}x^2 - \frac{1}{2}x = 51 \end{array} \right\}$ = the miles each travelled.

* III. Question 55 answered by Mr. J. Simmons

91 l. 11 s. 4 d.	$\frac{1}{2} \frac{4}{8} \frac{2}{4} \frac{2}{2}$	Is the share for Molly,		
72	19	10	$\frac{1}{2} \frac{4}{8} \frac{2}{4} \frac{2}{2}$	Is what Nan ought to take,
65	2	0	$\frac{2}{2} \frac{0}{8} \frac{1}{4} \frac{2}{2}$	Makes the part for Nelly,
<hr/>				If I've made no mistake.
229	13	4		

IV. Question 56 answered by Mr. Ja. Peirce.

Let $BC = 4 = b$, $AD = 7 = g$,
 $CD = 6 = c$, $AB = 5 = f$,
 $CD + BC = 10 = e$, $AD + AB = 12 = h$,
 $CD - BC = 2 = d$, $AD - AB = 2 = i$.

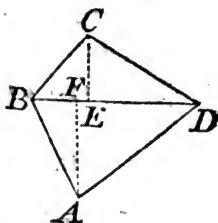
The area 2 a. 3 r. 24 per. = 29 sq. cha.
 = a . *Quere* diagonal $BD = y$.

$$(1). y : e :: d : \frac{de}{y} = DE - EB;$$

$$\text{and } y : h :: i : \frac{hi}{y} = DF - FB.$$

$$(2). \frac{yy + de}{2y} = DE, \text{ and } \frac{yy + hi}{2y} = DF.$$

(3).



* III. QUESTION 55 solved.

The numbers $5\frac{2}{3}$ and $4\frac{1}{3}$, or $\frac{50}{9}$ and $\frac{31}{7}$ are in proportion as 350 and 279; and the numbers $4\frac{1}{3}$ and $3\frac{2}{3}$, or $\frac{37}{9}$ and $\frac{11}{3}$ are to each other as 37 to 33. Now, $279 : 350 :: 37 : \frac{37 \times 350}{279}$; and hence the three shares must be in proportion as the three numbers $\frac{37 \times 350}{279}$, 37, and 33; or as 37×350 , 37×279 , and 33×279 ; that is, as the numbers 12950, 10323, and 9207; whose sum is 32480.

Whence, by proportion, we shall have as 32480 : 229 l. 13 s. 4 d.

$$\therefore \begin{cases} 12950 : 91 \text{ l. } 11 \text{ s. } 4 \text{ d. } \frac{2}{8} \frac{2}{4} \frac{2}{2} = \text{Moll's share,} \\ 10323 : 72 \text{ } 19 \text{ } 10 \frac{2}{8} \frac{1}{4} \frac{2}{2} = \text{Ann's share,} \\ 9207 : 65 \text{ } 2 \text{ } 0 \frac{2}{8} \frac{2}{4} \frac{2}{2} = \text{Nell's share.} \end{cases}$$

$$(3). \sqrt{\frac{4c^2y^2 - y^4 - 2dey^2 - d^2e^2}{4y^2}} = CE:$$

$$\sqrt{\frac{4g^2y^2 - y^4 - 2hiy^2 - h^2i^2}{4y^2}} = AF.$$

(4). These two last \times by $\frac{1}{2}y$, and added together give the area.

(5). Then by extracting the square root of the denom. and multiplying a by 4, you'll have

$$\sqrt{4c^2y^2 - y^4 - 2dcy^2 - d^2e^2} + \sqrt{4g^2y^2 - y^4 - 2hiy^2 - h^2i^2} = 4a.$$

(6). By squaring both sides of the last equation, and transferring the rational terms to one side, you'll have (after making $4c^2 - 2cd = k$, $-ddee = -l$; $4g^2 - 2hi = m$,

$$-bhii = -n;) 2\sqrt{ky^2 - y^4 - l} \times \sqrt{my^2 - y^4 - n} = 16aa - ky^2 - my^2 + 2y^4 + l + n.$$

$$\text{Let } 16a^2 + l + n = p, \text{ and } -ky^2 - my^2 = -qy^2.$$

(7). By squaring both sides of this last (p and $-q$ rightly placed) you'll have $4kmy^4 + 4ly^4 + 4ny^4 - 4lm y^2 - 4kny^2 - 4my^6 - 4ky^6 + 4y^8 + 4ln = p^2 + 4py^4 + q^2y^4 - 2pqy^2 + 4y^8 - 4qy^6$.

(8). But $4y^8 = 4y^8$ is destroyed; also by supposition $m + k = q$. Therefore $-4my^6 - 4ky^6 = -4qy^6$, which will be destroyed. Lastly, by transposing the known quantities to one side, and the unknown to the other, you'll have $4kmy^4 + 4ly^4 + 4ny^4 - 4py^4 - q^2y^4 + 2pqy^2 - 4lm y^2 - 4kny^2 = p^2 - 4ln$.

Let $4km + 4l + 4n - 4p - qq = r$; $2pq - 4lm - 4kn = s$, and $p^2 - 4ln = t$. Then $ry^4 + sy^2 = t$.

From whence will arise this theorem,

$$y = \sqrt{\sqrt{\frac{ss}{4rr} + \frac{t}{r}} - \frac{s}{2r}} = 7.682 \text{ chains, the longer diagonal; the other is } 7.554 \text{ chains.}^*$$

V. Question

* IV. QUESTION 56.

Constructions and other solutions of this question may be seen in *Simpson's Algebra* and his *Select Exercises*.

* V. *Question 57 answered by* Ja. Peirce, Wm. Whitworth, Jos. Wilkinfon, and Moses Bleathman.

Mar. 2. Sun's longitude $22^{\circ} 56' 34''$ \times . Declin. $2^{\circ} 48' 28''$ S. The Sun's meridian altitude, $34^{\circ} 21' 32''$.

Length of the shade, 117.056 inches; which doubled, gives the conjugate diameter of the oval 234.112 inches.

June 11. Sun's longitude	—	—	—	23	00	55'	41"
Declination north	—	—	—	—	23	29	48
Sun's altitude east or west	—	—	—	—	30	1	16
Length of the shadow	—	—	138.4	inches			
Doubled the transverse diameter	—	—	276.8				
The area of the oval	—	—	50916.0155				
$\frac{1}{3}$ Taken for the 3 solid bodies	—	—	16972.0051				
$\frac{2}{3}$ For the step	—	—	33944.0102				
Transverse diam. of step	—	—	116.716				
The conjugate diam. of the step	—	—	74.028				
The side of the cube	—	—	21.675				
Side of the dodecaedron	—	—	8.726				
Diameter of the globe	—	—	14.799				

VI. *Question*

* V. QUESTION 57 solved.

The method of solving this question is thus :

By astronomical tables find the sun's place or longitude to the two given times; and the obliquity of the ecliptic or the greatest declination for the same : then, by spherics, it will be, as radius : sine long. :: sine obliq. : sine of the present declinations. In the first case, the declin. taken from the colat. leaves the meridian altitude; and in the other, we shall have, by spherics, as s. lat. : s. obliq. :: radius : s. altitude. These altitudes being thus computed, we shall suppose to be $34^{\circ} 21' 32''$ and $30^{\circ} 1' 16''$ as in the original solution above.

Then, by plain triangles, as 1 (rad.) : 80 (length of staff) :: cotang. alt. : length of the shade; consequently 160×1.4622874 (cotang. $34^{\circ} 21' 32''$) = 234.034176 inches = the conjugate diameter, and 160×1.7305780 (cotang. $30^{\circ} 1' 16''$) = 276.89248 = the transverse diameter; and hence the area of the green is $276.89248 \times 234.034176 \times .78539$ &c. = 50895.58. Then $\frac{1}{3}$ of this being a number expressing the sum of the contents of the three solids, which are in proportion to one another as 1, 3, and 6, whose sum is 10; we shall have, as 10 : 50895.58

$\therefore \left\{ \begin{array}{l} 1 : 1696.519 = \text{the content of the sphere} \\ 3 : 5089.558 = \text{the content of the dodecaedron} \\ 6 : 10179.116 = \text{the content of the cube} \end{array} \right\}^3$; and, by

mensu.

* VI. *Question 58 answered by Moses Bleathman.*

I see a fault, but can't devise,
 Not for my life, in whom it lies:
 Wheth'r in the author, or the printer,
 Or else in me, the fault's amender.
 If I am right, the eldest son
 Had twenty-one years over-gone;
 The other sixteen years I see:
 But this does not with you agree.

Answer to the Prize Question.

Mr. Char. Mason, Mr. Tho. Cary, (who won the prize)
 Mrs. Mary Nelson, Mr. John Cary, Mr. Peter Ward, Mr.
 Peirce, Mr. Witworth, Mr. Carrington, Mr. J. White, Mr.
 Bleathman.

menfu. $\sqrt[3]{101791116} = 21.6722 =$ the side of the cube,

$\sqrt[3]{\frac{5089.558}{7.66311896}} = 8.7248 =$ the side of the dodecaedron,

$\sqrt[3]{\frac{1696.518}{\frac{1}{4} \times 3.14159\&c.}} = 14.7975 =$ the diameter of the sphere.

Again, for the diameters of the inner ellipse, or stone step, whose solidity is $\frac{2}{3}$ of the area of the outer one, and the difference of its diameters $= (276.89248 - 234.03418 =) 42.8583$; let $x =$ half the sum of its diameters, then the diameters will be $x \pm$

$21.42915 \left(= \frac{42.8583}{2} \right)$; and their product $x^2 - 21.41915^2$

(per quest.) $= 276.89248 \times 234.03418 \times \frac{2}{3} \times \frac{1}{4} = 8640.304$;

hence $x = \sqrt{21.42915^2 + 8640.304} = 95.3914$, and $95.3914 \pm 21.4291 = 116.8205$ and $73.9623 =$ the diameters of the inner ellipse.

* VI. QUESTION 58 solved.

Putting x and y for the two ages, we have, per question, $x^2 - y = 425$, and $y^2 - x = 235$ (omitting the 3d condition as superfluous); hence $y^2 = 235 \times x = x^2 - 425$, or $x^4 - 850x^2 - x = -180390$; in which equation $x = 21$; and then $y = x^2 - 425 = 16$.

Bleathman, Mr. Wilkinſon, Mr. Edmund Weaver, Mr. R. Hall, Mr. Joſ. Smith, answered this queſtion as below.

	Inches.
The ſide of each triangle of the tetrahed	41'853
The perpendicular altitude — — —	34'17283136
The ſide and altitude of the priſm — —	28'6209
Conſequently the ſide of the baſe of that } Part of the tetra. which is within the priſm. }	28'6209
Its perpendicular altitude — — —	23'3688
Its content in ale-gallons — — —	9'79793
The perpendicular altitude of the pyramid	5'25204
Its content in ale-gallons — — —	2'20203
The content of the two pyramids — —	11'99999
Content of the priſm when placed according } to the import of the queſtion in ale-gall. }	24'0000
The elevation of the priſm — — —	10'8039

Eclipſes

• PRIZE QUESTION ſolved.

Since the two ends of the priſm are filled up by two pyramids whoſe vertices meet within it, the height of the two together is juſt equal to the ſide of the priſm; and ſince a pyramid is $= \frac{1}{3}$ of a priſm of the ſame alt. and baſe, it is evident that $\frac{2}{3}$ of the priſm will be filled with liquor, that is, it will contain 24 gallons: which is one part of the demand. The other is to find the additional elevation of the priſm, which, being evidently $=$ the difference between the altitude of the tetradron and of the part of it which is let into the priſm, will be found thus.

By the Schol. page 403 Menſuration, $12 \sqrt[3]{6 \times 5 \sqrt{2}} =$
 $12 \sqrt[3]{30 \sqrt{2}} = 41'853$ inches $=$ the ſide of the whole tetradron;

and by page 81 and 145, we ſhall have $\sqrt[3]{\frac{36 \times 282 \times 4}{\sqrt{3}}} =$

$6 \sqrt[3]{\frac{188}{\sqrt{3}}} = 28'62092 =$ the ſide of the priſm $=$ the ſide of the tetradron which is within the priſm. And it is the difference of the altitudes of theſe two which is required. Now, from the demonſtration page 403 Menſuration, it appears that the ſide of a tetradron is to its altitude, as 1 to $\sqrt{\frac{2}{3}}$; and ſince the difference between 41'85300 and 28'62092 the ſides of the two tetradrons is 13'23208, we ſhall have $13'23208 \sqrt{\frac{3}{2}} = 10'80394 =$ the additional elevation required.

Eclipse of the moon, 1718.

Once this year will the earth's shadow quite hide the body of the moon from our sight, which will be on friday the 29th of august, at 8 at night, being a total eclipse of the moon. The calculation I have lately made, and compared with my former, from *Astronomia Car.*

	h.	m.	s.
The mean 8 august the 29th, evening	—	8	1 1
The mean anomaly of the earth	—	fig 210	55 2
Of D	—	010	43 16
Longitude of the sun	—	m 16	34 4
Of D	—	\times 16	28 37
Difference from the opposition want	—	—	5 27
Hourly motion of \odot 2' 26", of D 30' 7" differ.	—	—	27 31
27' 31" to 5' 27" :: 60 to the interval, add	—	—	11 0
The middle or equal time	—	8	12 1
To which time the sun's place is	—	m 16	34 6
D 's place	—	\times 16	34 44
Difference from the opposition past	—	—	38
Hourly motion of \odot 2' 26", of D 30' 8" differ.	—	—	27 42
As 27 42 to 38" parts :: 60 to interval sub.	—	—	1 23
Equal time of the true 8 august	—	29 8	10 38
Subtract Ω from D place refts argum. last	—	6 0	50 33
Reduct. sub. 12" D 's latitude south descend.	—	—	4 22
From hourly motion of D 29' 37" sub. ho. mot. \odot	—	—	2 26
Remains the hourly motion of D á \odot	—	—	27 11
17' 11" to red. 12" :: 60" to time of red. add	—	—	23
Correct time of the true ecliptic opposition	—	8	11 1
Semidiameter \odot 15' 49", semidiameter of C	—	—	14 20
Horizontal parallax \odot 15", D 's 53' sum	—	—	53 15
Semidiameter. \odot subtr. remains femid. \odot 's shad.	—	—	37 26
Semidiameter D 14' 20" add, sum of femidi.	—	—	51 46
Latitude D subtract, remains parts deficient	—	—	47 24
14' 20" : 6 dig. :: 47' 24" parts defic. to dig.	—	20	2 0
Interval of ecliptic 8 and max. obscur. add	—	—	44
Minutes of incidence and half tarriance	—	—	51 35
The time of half duration	—	—	1 53 51
Equation of time add	—	—	11 53
Apparent time of greatest obscuration	—	—	7 59 8
Difference of meridians subtract	—	—	6 0
Apparent time max. obscuration at Coventry	—	—	7 56 8
Half continuance in total darknes	—	—	22 41
27. 11. 60. : 22. 41. to half duration in total darknes	—	—	50 4
Whole duration in total darknes	—	—	1 40 8

Mathem.

P

Hence

Hence the apparent times at London and Coventry.

London.

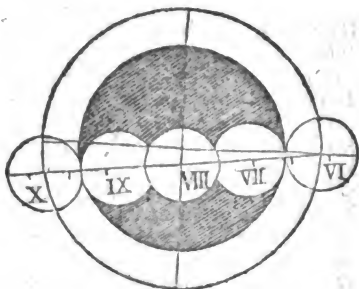
Coventry.

h. m.

h. m.

6	5	Beginning august 29th evening	—	—	5	59
7	9	Beginning of total darkness	—	—	7	3
7	59	Greatest obscuration	—	—	7	53
8	49	End of total darkness	—	—	8	43
9	52	End of the eclipse	—	—	9	46
3	47	Whole duration				

This type shews upon the figur'd line of the moon's way, the time of the beginning, immersion, greatest darkness, emersion and end, by the place of the moon's center on that line, at her passage through the dark shadow of the earth: the other lines of the moon's eclipses, in my last, I explain'd, so needless here. The moon's latitude at the beginning is 16 seconds north descending, and at the end 9' 38" south descending.*



On the 3th of march, at 3 afternoon, and 13th of september, at 9 morning, moon's eclips'd invisible. On the 19th of february, at midnight, and 15th of august, at 2 in the morning, sun's eclips'd invisible.

Note, The 20th of august the moon rises not till 20 minutes after the beginning of the eclipse.

Paradoxes

* This eclipse of Aug. 29th was observed thus.

Places	Observers	Begin.	To. Im.		Emersi.		End.	
		h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	
Padua	J. Poleni		7 49	49 36	4	10 41	2	Ap. time
Bologna	G. Rondelli		7 47	49 27	40	10 37 36		Tr. time
Bologna	G. Manfredi	6 42 13	7 47	50 29	20	10 38 51		Tr. time
Bologna	A. Gifilieri	6 40 23	7 46	37 9	33 50	10 37 42		
London	M. Folkes		7 2	08 46	30	9 52	0	
Wanstead	Dr. Pound		7 2	41 8	48 18	9 53	0	Ap. time

In

Paradoxes to be answered next year.

Par. 1. There's a certain country in South America, many of whose savage inhabitants are such unheard of canibals, that they not only feed upon human flesh, but also some of them do actually eat themselves; and yet they commonly survive that strange repast.

Par. 2. There's a certain European city, whose buildings being generally of firm stone, are (for the most part) of a prodigious height, and exceeding strong: yet it is most certain, that the walls of those buildings are not parallel to one another, nor perpendicular to the plain on which they are built.

Par. 3. There are two distinct places on the continent of Europe, so situated in respect to one another, that tho' the first lies east from the 2d, yet the 2d is not west from the first.

Par. 4. There's a remarkable place on the globe of the earth, of a very pure and wholesome air to breathe in, yet of such a strange and detestable quality, that it's absolutely impossible for two of the intirest friends that ever breathed, to continue in the same in mutual love and friendship for the space of two minutes of time.

I design next year some new paradoxes, which I doubt not my correspondents will compose for this place.

New

In this year, from the 18th of January to the 5th of February, new stile, a Comet was observed at Berlin by Mr. Christ. Kirk, thus:

At 10 at night	Longitude	Latitude	
Jan. 18	27° 26' 27"	69° 18' No.	
21	16 25½ 8	48 42	
23	9 28½	39 45	
26	5 25½	32 55	
27	4 41	31 24	
28	4 4	30 13	
30	3 4	28 23½	
31	2 43	27 40	
Feb. 1	2 25	27 1	
2	2 10	26 22	
5	1 39	24 53	

From these observations it is found that the comet's descending node was in about $21\frac{1}{2}$ degrees of Aries; the angle of its orbit and ecliptic $69\frac{1}{2}$ degrees, it passing within 2 or 3 degrees of the pole of the world, and cutting the equator at about $20\frac{1}{2}$ deg. from the equinoctial point; its perigee was in $60^{\circ} 6' 17''$ with $67^{\circ} 7'$ north latitude, it being in

its perigee Jan. 18. 3h. 9min.

P 2

*New Questions.**I. Question 59, by Mr. Doidge, of Portsmouth.*

One ev'ning, as I walk'd to take the air,
 I met a damsel beautiful and fair:
 Her matchless charms did fix my roving heart,
 Which, till that moment, scorn'd love's proudest dart.
 Unto this fair I did myself address,
 With all the love that lovers can express.
 Then streight unto her father's house we went,
 And in love's stories all the time we spent.
 A curious garden joined thereunto,
 And all that lovely was, i'th' same there grew:
 The silver streams, and pleasant walks so nice,
 Made it appear like to a paradise.

Amidst the garden she a knot would place,
 The better still her garden for to grace.
 The content of it should exact agree,
 To be in feet one hundred sixty-three:
 A polygon's the form; but it must bear,
 Of just ten equal sides, and regular.

Then sir, said she, pray try your skill to find
 The side's true length, to form the knot design'd.
 And to reward the pains you take for me,
 I freely then your wedded wife will be.
 These words with joy so fill'd my breast, that I
 Thought that each moment was eternity,
 Until that I the side's true length had found,
 And then in pleasure evermore abound.
 But ah! with pains I've try'd all ways about,
 And all in vain; I cannot find it out.

Assist, fair ladies, one with grief oppress'd,
 And send an answer to this one request.

II. Question 60, by Mr. Tho. Cary, of Lynn.

Within my garden I've a pond that's round,
 Whose surface equal to 5028 $\frac{1}{4}$ square feet is found:
 In th' midst of which, a pole stands just upright
 Above the plain, one hundred feet in height:
 This pole being broke into two parts,
 Come, tell this query now, ye men of arts.
 The broken piece fell just at the pond's brink:
 How long is then the piece left, do you think?

III. Question

III. *Question 61, by Mr. Peter Ward.*

You that delight in figures, try your skill,
 A magic square with numbers for to fill.
 One to a hundred numbers there must be;
 Which to the numbers of the squares agree:
 But farther still you must them so contrive,
 Twenty-two ways to make five hundred and five.
 No two squares alike in numbers must be;
 But ten in length, and ten in breadth, let's see.

IV. *Question 62, by Mr. Wm. Whitworth, of Northampton.*

Ingenious sons of art, I new request,
 That you my artificer will assist.
 Also be pleas'd to let me understand,
 How to effect my purpose now in hand.
 A cistern made of lead that's half inch thick,
 In oblong prism form; but honest Dick
 With me agreement made the length to be
 In ratio to the breadth, as five to three;
 And must hold fifty bushels exactly. }
 But this is what I most of all desire,
 To have it, that the least lead will require;
 That is, what will the least of surface have,
 Is what from you, I with submission crave.
 Also its length and depth to me expound,
 And what 'twill cost at three half pence a pound.

V. *Question 63, by Mr. Lewis Evan, from Carmarthenshire*

Ten partners bought the hay next year to grow
 Upon the meadow field describ'd below.
 The price is forty pounds. The mead contains
 Just sixty acres, or six hundred chains.
 A pays a sum to be found out, and B
 Does pay five shillings more than A; so C
 Five shillings more than B; the same excess
 Continues to the end; nor more, nor less.

Three sides it has, whereof the base is fifty,
 O'th' two slope lines, the longest measures forty,
 The other thirty chains. This mighty care
 Torments their minds, how ev'ry one's due share
 According to the money he pays in,
 Shall be laid out by 'tself. For they begin
 To think, no other way will do so well;
 That partnerships are tedious, most can tell.

At the acuteſt angle, they've indeed
 Amongſt themſelves moſt willingly agreed,
A's ſhare ſhall be, the reſt in order on,
B, C, D E, ſo forth, till all is done;
 Thoſe perpendicular lengths, which from the baſe,
 Erected at right angles, ſhall thoſe ſhares
 Divide aſunder: and how many chains
 O'th' baſe each ſhare takes up: Whoe'er the pains
 Shall take to ſhew, himſelf may well aſſure,
 He ſhall thereby their heartieſt thanks procure.

VI. *Queſtion 64, by Mr. Rob. Beales.*

A young man had left him by his old grannum
 Two hundred pounds; but nothing per annum.
 'Twas not to be paid him till nine years three quarters,
 Which vexed him ſore, and put him to tortures;
 'Cause being juſt marry'd, he wanted the pelf,
 Which made him bethink what to do with himſelf.

So he went to a miſer, whoſe riches were great,
 And did the whole ſtory unto him relate;
 Who ſaid, if his ſtory in truth could be found,
 He'd venture to give him one hundred pound
 Then down on the nail; which made him look brave,
 And tell the old lurch, the full ſum he ſhould have,
 As above, at the time: ſo ſecur'ty was made,
 And an hundred pounds he had got for to trade.

Now what compound int'reſt did the miſer demand,
 Per cent. per annum for the money in hand?

The Prize Queſtion, 10 diaries to the anſwerer.

Ladies, as you ſet many right,
 Pray do the ſame for a wheelwright;
 And for your pains I will content you,
 If you explain this paper ſent you.

In two wheels if there be inſcribed
 A polygon that's equal ſided;
 The leſs five ſides, the other ſeven;
 Of which the areas they are given
 In proportion or analogy,
 Exactly as thirteen to three.

But theſe to find, depends upon
 The juſt length of a pendulum
 That vibrates ſixty times and one
 Exactly in one minute's ſpace:
 This, being found, is the true baſe

To

To two sides of the pentagon;
 And bounds the angle (which is known).
 Then by the length of this subtense,
 Or base, there will by inference,
 Be found the parts of ev'ry figure,
 First of the less, and then the bigger:
 Also each wheel's periphery;
 For that directs the smith and me.
 And for that lady's courtesy,
 Who first sends these true lengths to me,
 I'll give next year ten ladies' diaries,
 As prize for answering these queries.

1719.

Answers to the Paradoxes proposed last year.

Par. 1. **A** Draſtea ſays, If they don't eat (their meat) them-
 ſelves, who can eat for them, in ſuch manner as
 to ſuſtain their life?

Par. 2. All walls are endeavour'd to be built perpendicular to the tangent (and point to the center) of the earth, where they, if continued, would meet in a point, and confequently are not parallels, and but in one point only can a perpendicular be raiſed on a horizontal plain: vid. 3th par. 1715, answer'd in the diary for 1716, and *Euclid*. lib. 11 pr. 13.

Par. 3. Any two places on the globe that differ in, or have latitude.

Par. 4. This paradox by ſome answer'd thus. 'Tis impoſſible for two perſons to be in one and the ſelf ſame individual place together.

Others ſay, two in the throne can't continue in mutual love and friendſhip.

Mr. Hum. Marſhjuſtum ſays, by reaſon of the earth's motion they cannot continue in the ſame air.

Solutions.

Solutions to the last year's questions.

* I. *Question 59, answer'd by Anna Philomathes.*

Sir, my assistance ne'er shall wanting be,
To ease a friend that's in extremity.
When first I found how you with grief were press'd,
A moving pity touch'd my tender breast;
Alas! thought I, his ruin is too sure,
If there's no way but this to work the cure;
But viewing well the query o'er again,
I found the antidote that cures your pain.

55.23 inches = to the polygon's side = 4.602 feet.

† II. *The 60th question answer'd by Mr. W. Laughton.*

Let $r = 40.008$ the radius of the pond; $h =$ to the piece broke off; and $p =$ to standing piece. Then $h + p = a = 100$,

* I. *QUESTION 59 solved.*

By mensuration, $\frac{5}{2}\sqrt{5} + 2\sqrt{5}$ or 7.6942088 drawn into the square of the side of a decagon is its area; wherefore the side will be $\sqrt{\frac{163}{7.6942088}} = 4.6027$ nearly.

† II. *QUESTION 60 solved.*

Algebraically.

The square of the radius of the circle is $\frac{5028\frac{4}{7}}{4 \times .78539 \&c.} =$

$\frac{8800}{7 \times .78539 \&c.} = 1600.644$, which put $= a^2$; also put $c = 100$

the whole height of the pole, and $x =$ the part standing. Then will $c - x$ be the part broken off, and is the hypotenuse of a right-angled triangle whose two legs are a and x ; consequently

$a^2 + x^2 = (c - x)^2 = c^2 - 2cx + x^2$; and hence $x = \frac{c^2 - a^2}{2c} = 41.99678 =$ the length required.

Geome-

100, and $hh = pp + rr$ by 47 Euclid 1. Hence $hh + 2bp + pp = aa$. And $hh - pp = rr$. By subtracting, $2bp + 2pp = aa - rr$. Then $p = \frac{aa - rr}{2b + 2p} = \frac{aa - rr}{2a} = 41.9968$ feet.

III. *The 61st question answer'd by Mr. Mich. Eling, Mr. Jo. Smith, Mr. Williams, John Tinder, Alex. Naughley, J. Clifford, J. Simmons, W. Kendall, and W. Rubens; but there are many different ways of answering or filling this magic square.*

The following one is thus fill'd by Mr. J. Harris.

11	92	12	88	14	15	16	84	83	90
100	82	26	27	67	35	59	58	50	1
99	19	75	74	33	66	42	43	51	3
2	20	76	73	34	36	60	57	49	98
4	81	25	28	68	65	41	44	52	97
94	21	77	72	32	37	61	56	48	7
5	80	24	29	69	64	40	45	53	96
6	79	23	30	70	38	62	55	47	95
93	22	78	71	31	63	39	46	54	8
91	9	89	13	87	86	85	17	18	10

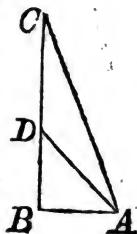
These numbers make 505 ten times in the lines, ten times in the columns, and twice diagonally.

IV. The

Geometrically.

Here are given the base and the sum of the hypothenuse and perpendicular, of a right-angled triangle; to construct the same. Which will be done thus:

Making AB the radius of the circular pond, and BC the pole perpendicular to it; join A, C ; and draw AD making the angle $DAC = \angle DCA$; so shall BD be the part standing, and DA or DC the part broke off.—For, because of the equality of the \angle s DCA, DAC , their opposite sides DA, DC will be equal. Q. E. D.



IV. The 62d question answered by *Anna Philomathes*, who for the honour of the fair sex, I can assure the world, from an ocular demonstration at a visit I once made her, that these mathematical performances are purely her own.

Your problem, Mr. *Whitworth*, I have told,
 Tho' found it somewhat knotty to unfold.
 Did you think it beyond our sex's parts,
 That assistance you crave from the sons of arts?
 If you'll please to view here what I write below,
 Full answer to your queries I will show.

Let $b = 5$, $c = 3$, and $aaa = 107520 =$ cubic inches in 50 bushels, also let $x =$ length: then will $\frac{cx}{b} =$ to breadth, $\frac{baaa}{cxx} =$ to the depth, and $\frac{ccxxx + 2bbaaa + 2bcaaa}{bcx} =$ to least superfi. of cist.*

The

* IV. QUESTION 62 solved.

The above original solution is false as well as that given in the *Diarian Repository*, they both making the internal surface a *minimum*, which is contrary to the intention of the question; for it expressly declares "To have it that the least lead will require" and consequently the difference between the solids made up of the external and internal dimensions must be the *minimum*. Wherefore putting the

internal $\left\{ \begin{array}{l} \text{length} = 5x \\ \text{breadth} = 3x \\ \text{depth} = y \end{array} \right\}$, the external dimensions $\left\{ \begin{array}{l} 5x + 2 = \text{length} \\ 3x + 1 = \text{breadth} \\ y + \frac{1}{2} = \text{depth} \end{array} \right\}$ will be

And hence $15x^2y = 107520$, and $5x + 1 \cdot 3x + 1 \cdot y + \frac{1}{2} - 15xy$ or $\frac{1}{2}x^2 + 8x + 1 \cdot y + \frac{1}{2} =$ a *minimum*. The value of y being exterminated out of this equation, by means of the first, and its fluxion put $= 0$, we at last obtain $15x^4 + 4x^3 - 57344x - 14336 = 0$; in which equation the root x is $= 15.630773$. Wherefore $5x = 78.153865 =$ internal length, $3x = 46.892319 =$ internal breadth, and $y = \frac{107520}{15xx} = \frac{7168}{xx} = 29.338444 =$ internal depth;

also, by adding 1 to each of the former numbers and $\frac{1}{2}$ to the latter, we have 79.153865 , 47.892319 , and 29.838444 for the external length, breadth, and depth. From the continual product of these three taking 107520 the content of the inside, there remains 5594.34 for the cubic inches of lead in the cistern; and this multiplied by .409618 lb. the weight of a cubic inch of lead according to *Ward*, the product is 2291.54 lb. of lead, which at $1\frac{1}{2}$ d. a-pound, amounts to 14 l. 6 s. 5 d. 1.24 q.

The fluxion thereof is $\frac{2ccx^3\dot{x} - 2bba^3\dot{x} - 2bca^3\dot{x}}{bcxx} =$
 $2ccx^3\dot{x} - 2bba^3\dot{x} - 2bca^3\dot{x} = 0$. Therefore $x =$
 $\sqrt[3]{\frac{bba^3 + bca^3}{cc}} = \text{length} = 78.181426 \text{ inches, } \frac{cx}{b} =$
 breadth = 46.9088 inches, and $\frac{ba^3}{cx} = \text{depth} = 29.313 \text{ in.}$

The purchase 14*l.* 1*s.* 7½*d.*

* V. *The 63d question answered by A. Philomathes, T. Dodd, H. Walker, W. Crabb, Jo. Smith, W. Hawney, J. Jennings, C. Chorley, J. Finclair, Geo. Nash, A. Naughtley, G. Hare, Ja. Royston, Mary Nelson, J. Clifford, J. Simmons, Jo. Wilkinfon, Beata White, and John Cuning.*

Sharers.	Mustpa.	Share of	Len. on base	Leagth perp
	<i>l. s. d.</i>	<i>a. r. p.</i>	chains	chains
A	2 17 6	4 1 10	10.723	8.04
B	3 2 6	4 2 30	4.768	11.61
C	3 7 6	5 0 10	3.873	14.52
D	3 12 6	5 1 30	3.438	17.10
E	3 17 6	5 3 10	3.177	19.48
F	4 2 6	6 0 30	3.003	21.73
G	4 7 6	6 2 10	2.876	23.89
H	4 12 6	6 3 30	3.140	20.00
I	4 17 6	7 1 10	4.261	14.32
K	5 2 6	7 2 30	10.738	$\alpha \Delta$
Sum	40 0 0	60 0 0	49.999	

VI. The

* V. QUESTION 63 *solved.*

By the nature of arithmetical progression, having given the common difference $5 = d$, the number of terms $10 = n$, and the sum of the series $40 \times 20 = 800 = s$; there will be found the first term

* VI. *The 64th question resolved by A. Philomathes, T. Dodd, Lewis Evan, W. Crabb, J. Smith, W. Hawney, W. Armstrong, W. Loughton, J. Jennings, C. Chorley, Anne Harris, J. Tafft, and several others.*

The miser demanded 7*l.* 7*s.* 4½*d.* per cent. per ann. comp. int.

The

$$\text{term } a = \frac{2s - dn \cdot n - 1}{2n} = \frac{1600 - 450}{20} = 57\frac{1}{2}s. = 2*l.* 17*s.*$$

6*d.* = *A*'s share of the money, and by the constant addition of 5*s.* all the rest will be found to be as in the 2d column of the original solution above.

Then, their shares of the field will be in proportion as their sums of money, and since the triangle is evidently right angled, and its area = 30 × 20 = 600 chains = 60 acres, we shall have, as 40 *l.* : 60 acres or as 2 : 3 :: 2*l.* 17*s.* 6*d.* : 4·3125 acres = 4*ac.* 1*ro.* 10 poles = *A*'s share, and as 2*l.* : 3 :: 5*s.* : 3·75 *ac.* = 1*ro.* 20 poles = the common difference; which being continually added will give the several shares as in the 3d column.

Again, for the bases and perpendiculars: Since the first and last parts are triangles similar to the whole field, and similar triangles being as the squares of their like sides, we shall have, as

$$\begin{aligned} \sqrt{60} : \sqrt{4\cdot3125} &:: \begin{cases} 40 : 10\cdot723 = A\text{'s base} \\ 30 : 8\cdot042 = A\text{'s perpendicular,} \end{cases} \\ \text{and } \sqrt{60} : \sqrt{7\cdot6875} &:: \begin{cases} 40 : 14\cdot317 = K\text{'s perpendicular} \\ 30 : 10\cdot738 = K\text{'s base.} \end{cases} \end{aligned}$$

Then to the first and last areas add their adjacent ones, and the sums will be the next similar triangles; whose sides being calculated in the same manner, their perpendiculars will be those in the last column, and the differences of the bases will be the bases in the column next to it.

* VI. QUESTION 64 solved.

If *r* be put for the rate of 1*l.* by the nature of compound interest, we shall have $100 \times \overline{1+r}^{\frac{1}{4}} = 100$, or $\overline{1+r}^{\frac{1}{4}} = 1$, or $\overline{1+r}^{\frac{1}{4}} = 1$, or $\overline{1+r}^{\frac{1}{4}} = 1$; and $r = 16^{\frac{1}{19}} - 1 = \cdot 07368$. Hence the rate per cent. is $100 \cdot 07368 = 7\cdot368 = 7*l.* 7*s.* 4*d.* 1·28*q.*$

The Prize Question answered by Anna Philomathes, W. Hawney, Joliah Clayton, J. Buckey, Philomathematica, Luke Cullimore, Mary Nelson, Jo. Smith, E. Elphick, C. Maſon, T. Orme, Henry Hale, J. Jennings, Ja. Pearce, W. Doidge, Cha. Chorley, Anne Harris, and W. Whitworth, before Candlemas-day, and afterwards by Tho. Cary, J. Cary, G. Hare, J. Stocks, R. Whitehead, Beata White, and Peter Ward.

W. Whitworth's answer.

The lengths of pendulums are reciprocally proportionable to the ſquares of their vibrations.

Therefore as $\text{sq. } 61 = 3721 : 3600 :: 39'2 : 37'9252 = b$ the ſubtenſe, whence the ſide a muſt be found by this theorem: *If a quadrangle be inſcribed in a circle, the rect-angles of the two diagonals will be equal to both the rect-angles of the oppoſite ſides.*

Now the diagonals being each equal to the ſubtenſe b , the theorem is $aa + ba = bb$; ergo, $a = \sqrt{bb + \frac{1}{4}bb} - \frac{1}{2}b = 23'439062$ inches, the ſide of the pentagon.

Then b being the hypothenuſe of a rectangle triangle deſcribed in a circle, and cd part of the diameter (as far as where the perpendicular falls) the baſe; the perpen. being a and the other part of the diam. df ; we have $\sqrt{bb - \frac{aa}{4}} = cd$; and $\frac{1}{4}aa \div cd = df$; and $cd + df = \text{diamet. required}$. Alſo the area of the pentagon will be $945'2107$. Then $3 : 13 :: 945'2107 : 4095'9133912 = \text{area of heptagon}$, $3'633912 : 1 :: 4095'91$ in duplicate ratio, to ſide of the heptagon. Then the other parts are eaſily found, as below.

Parts.		Pentagon.		Heptagon.
The area of the ———	—	945'2107	—	4095'9133
Diam. of circum. circle	—	39'8768	—	76'8283
Diam. of inſcribed circle	—	32'2611	—	69'1047
Circumſcribing circle	—	125'2768	—	241'3637
Inſcribed circle	—	101'3510	—	217'0994

Of the Eclipses in 1719.

Four times this year, in their natural course, will the sun and moon be deprived of giving light to us; the calculation I have supputated from *Astronomia Carolina*, the tables of the celebrated Mr. *Tho. Street*.

1. Sun eclipsed the 8th day of february, at 6 o'clock in the morning, the sun being then not risen, can't be seen by us in the british islands, but in the eastern countries it will be a considerable deliquium.

2. Moon eclipsed on the 23d. of february, at 50 min. after 7 in the morning, but the sun rising half an hour before 7, the moon consequently must be set, as being then diametrically opposite, so the moon immerges just as the eclipse begins, and makes it invisible to us; but to the Western islands it will appear 5 digits eclipsed on her southern limb.

3. Sun eclipsed on tuesday the 4th day of august, at 6 in the afternoon; but it may be invisible, the moon's south latitude so depresses her as not to interpose between the sun and our sight.

4. Moon eclipsed, and visible on tuesday the 18th day of august, at 8 o'clock in the evening.

					h. m. s.
The equal time of the true 8 at Coventry	—	—	—	—	7 44 3
The time of reduction add	—	—	—	—	3 23
Correct time of true 8 in the ecliptic	—	—	—	—	7 47 26
Equation of time add	—	—	—	—	2 36
The apparent time of 8	—	—	—	—	7 50 2
Interval of the true 8 and the greatest obscur. sub.					6 46

Hence at Coventry, August 18th evening.

					m. h.
The beginning	—	—	—	—	VII 18
The middle or greatest obscuration	—	—	—	—	VIII 15
The end	—	—	—	—	IX 13
The whole duration	—	—	—	—	I 55
Digits eclipsed north	—	—	—	—	3 D. 3'. 42".
The latitude of the moon at beginning	—	—	—	—	42'. 55". S. D.
Latitude at the end, 48' south descending.					

It

It would be much for the improvement of astronomy, and honour of our nation, if persons who have well adjusted pendulums and proper instruments, would observe the times and parts of the eclipses, and communicate them; that eclipse of D 9 sept. 1717, was observed in latitude 55 to be obscured about 7 digits.

The three observations following were made and adjusted to the city of Coventry by an accurate hand.

1717. Oct. 9d. 13h. 12' 40" Jupiter's 3d satellite emerged.

1717. Dec. 5 9 22 00 Jupiter's 2d satellite immerg.

1717. Jan. 28 7 16 40 Jupiter's 1st satellite emerged.

New Paradoxes.

1. There are divers places on the continent of Africa, and the islands of Sumatra and Borneo, where a certain kind of sun-dial being duly fix'd, the gnomon thereof will cast no shadow at all, during several seasons of the year; and yet the exact time of the day may be known thereby.

2. There is a certain island (whereof mention is made by several of our latest geographers) whose inhabitants cannot properly be reckoned either male or female, nor altogether hermaphrodites: yet such is their peculiar quality, that they're seldom liable to either hunger or thirst, cold or heat, joy or sorrow, hopes or fears, or any such of the common attendants of human life.

3. There is a very remarkable place upon the terraqueous globe, where all the planets, notwithstanding their different motions and various aspects, do always bear upon one and the same point of the compass.

4. There is a large and famous country on the continent of Africa, many of whose inhabitants are born perfectly deaf, and others stone-blind, and continue so during their whole lives; and such is the amazing faculty of those persons, that the deaf are as capable to judge of sounds, as those that hear, and the blind of colours, as those that see.

5. *Scholasticus* sends the following in latin, out of *Owen's* epigrams.

Dic quibus hoc animal terræ nascatur in oris,
Masculus est matur cui, mulierque pater.

New Questions.

I. *Question 65, by Mr. Henry Walker.*

When first *Columbus*, with advent'rous mind,
 The ocean cross'd, a western world to find,
 With him a gentle Spaniard, young and fair,
 Saw, and confes'd the power of beauty there :
 An Indian virgin first engag'd his love ;
 She innocent, his passion did approve ;
 And crown'd the happy lover, I am told,
 With native beauty, and with native gold.
 A wedge of gold (herself the lovelier prize)
 She brings ; whose length and depth who multiplies,
 Produces ninety-six ; the breadth by depth fourscore,
 The length by th' breadth one hundred twenty more.
 The sides true measures, what, I do demand ;
 And would the wedge's value understand ?

II. *Question 66, by Mr. W. Doidge.*

In the latitude of 50 forty-eight,
 I saw a rainbow beautiful and bright ;
 It bore north-east, three quarters east, as I
 By all my care and art could best descry.
 What was it of the clock I fain would know,
 And beg that you the same to me would show.

III. *Question 67, by Mr. W. Hawney.*

What number of * guineas and pistoles, I pray,
 (With no other coin) will one hundred pounds pay ?
 And how many ways ? Pray declare unto me ;
 And I'll give you a pot whene'er I you see.

* Guineas at 21 s. 6 d. pistoles at 17 s.

IV. *Question 68, by Mr. John Leddell.*

Within my garden I've a piece of ground,
 A circle's arch that is exactly round :
 This arch's fine, in length just 30 feet ;
 Its versed sine in length is ten compleat.
 Now I would have this arch continued round,
 Till the sine's length forty five feet is found.
 Ye men of arts, now to oblige your friend,
 Of this new arch's versed sine the length pray send.

V. *Question*

V. *Question 69, by Mr. Jo. Smith.*

Three countrymen in Lincolnshire,
 A meadow ground did buy
 For ninefcore pounds; to their desire,
 In oval form did lie.
 The conjugate was forty chains,
 The focus point was found
 Just fifteen chains, by mighty pains,
 From th' center of the ground.
 Now *A* would in the middle be,
 And *Y*'s abscissa were
 Just eighteen chains; whereas that *E*
 His ordinate was near
 To thirty chains rightly apply'd.
 Now what shall each man pay?
 And how much land? I pray, don't hide
 Such things as needful be.

VI. *Question 70, by Mr. J. Dodd.*

As visiting a friend, the other day,
 Tho' unprepar'd, I then must needs survey
 A piece of land, exact triangular;
 One side of which I only cou'd come near:
 Quoth he, This angle once was found to be
 Thirty degrees, and minutes forty-three:
 The sides including it when multiply'd
 Together, will (if that be any guide)
 I formerly have heard, exactly give * 168⁷⁵
 In chains * eightfcore and eight, tenths seventy-five.
 Th' assistance only of Sir *Jonas Moore*,
 Thro' his compendium, I could then procure;
 Without the help of any instrument,
 I'd have the rule to find out the content.

VII. *Question 71, by Alex. Naughley, of Cumberland.*

A stone for a hog-trough, I'd have to contain
 Inches five thousand four hundred; and then.
 Its length, breadth, and depth, to the sum must amount
 Of fifty-seven inches, as housewives account;
 And the trough must be made exactly to hold
 Five Winchester pecks; or I'm sure of a scold.
 So pray, you fair ladies, send me what directions:
 The workman may want, to find the dimensions:
 Or what they must be (like within as without).
 An't please you to show, it will bring us both out.

Q 3

VIII. *Quest-*

VIII. *Question 72, by Mrs. Mary Nelson.*

A captain on the seas, who was both brave and bold,
 Had taken from his foes a chest well fill'd with gold;
 Then all his men were call'd; he straightway let them know,
 That each should have his share, as is express'd below.
 Now, ladies, answer this: How many men there were,
 And how much money each allotted to his share?

The first took one pound and a hundredth part of the remainder. The 2d two pounds and two of the remainder, and so on, till the last man, who had all that was left. So the money was equally divided. If the number of men were added to the number of pounds in each share, the square of that sum would be equal to four times the number of pounds they had in the chest.

IX. *Question 73.*

Show me how to find, what's the least number
 That you can divide without a remainder?
 By given divisors? As the digits nine;
 For a true cannon, I'd give a pint o' wine.

X. *Question 74, by Mr. Crabb.*

Let the dimensions of a spheroid cask
 Be such as here are under; then I ask
 The difference in wine gallons, that are
 Between the greatest cube and cylinder
 That can be inscribed in the same. Pray try;
 And let us know in your next diary.

Diameter at the head	31.8	} inches.
Diameter at the bung	40	
Length — —	52.8	

The Prize Question.

The answerer may by lot win 10 of these diaries.

Ladies, I have a wager laid,
 Which I shall lose without your aid:
 In Turner's yard lay a wheel nave,
 Which late was turned in his lathe,
 And is, in shape, a spheroid's frustra;
 But for the axeltree, there must a
 Hole be made, whose vacuity
 The frustum of a cone must be;
 And base breadths in analogy,

}

Or

Or ratio, fixed is and certain,
 Being as twice eight is to thirteen;
 And the length in inches eighteen.
 The hole being made of this said form,
 A gallon is to hold of corn,
 And two tenths more of cubic inch.
 Pray, ladies, help me at this pinch,
 And tell the breadth each base must be.
 To find the nave's solidity,
 Four times the breadth of the bigger base
 Of the cone's frustra (in this case)
 Is the greatest thickness of the nave;
 Thrice the said breadth each end must have.
 Now, ladies, I most humbly crave
 Your help in the next diary,
 To send me the solidity;
 And also the periphery
 O'th' hoops that this nave environ
 Four inches from each end (of iron).
 Having your help, I'm yours till death,
 And you'll oblige each philomath.

1720.

Paradoxes answered.

Par. 1. A Horizontal dial under the equinoctial line casts no shadow at 12 o'clock twice every year.

Par. 2. If puppets may be called inhabitants, it will answer this paradox.

Par. 3. Under either of the poles of the world.

Par. 4. The blind and deaf have capacity to judge of colours and sounds as well as those that see and hear, tho' they want the senses of seeing and hearing.

Par. 5. Progenitos vidi numerosus vere * Gyrinos
 Hæc rana, hic bufo; mater hic, illa pater.

* A tadpole, young frog, or toad.

Solutions to the questions.

* I. The 65th question answer'd.

A wedge of gold delightful to the eyes,
The charming fair was much the greater prize.

Tho' this question was false printed (breadth for depth) in the 10th line, yet the true answer was given by several, but with some variety as to the value of the gold, as either standard, pure, or allay'd. The length 12, breadth 10, and depth 8 inches, and if $\cdot 10083$ inch. = 1 ounce, and the troy pound = 42*l.* 10*s.* the value was 33718*l.* 19*s.* 9½*d.*

† II. Question 66, answered by William Armstrong.

If the sun was near the equinox, which is unlimited in the question, it was 33 min. 45 seconds past 3 evening.

III. Question

* I. QUESTION 65 solved.

From the question it is evident that the breadth is to the length as 80 to 96, or as 5 to 6, and to the depth as 120 to 96 or as 5 to 4.

Now the product of 4 and 5 is 20, which is similar to the product 80 in the question; and each of the proportional numbers 4, 5, 6 will be to the corresponding numbers required, as the root of 20 to the root of 80. Wherefore as ($\sqrt{20} : \sqrt{80} :: \sqrt{1} : \sqrt{4} ::$)

$$1 : 2 :: \begin{cases} 4 : 8 = \text{the depth,} \\ 5 : 10 = \text{the breadth,} \\ 6 : 12 = \text{the length.} \end{cases}$$

Hence the content is $8 \times 10 \times 12 = 960$ inches. And, using Ward's tables, $960 \times 10\cdot359273 \text{ ounces} = 80 \times 10\cdot359273 = 828\cdot74184 \text{ lb.}$ which at 22*l.* 10*s.* per lb. amount to 35221*l.* 10*s.* 6*d.* 3·072*q.*

† II. QUESTION 66.

In the above original solution to this question, it is justly remarked that the question is unlimited, as the declination or time of the year should have been given, and then the solution would have been very easy: For as the rainbow is formed directly opposite to the sun with regard to the observer, the bearing of the sun will be S. W ¼ W. so that in a spherical triangle would be given two sides (= the colat. and codeclin.) and an angle (the sun's azimuth or bearing from the north) opposite to one of them (the codeclin.), to find their included angle = the measure of the time from noon required.

* III. *Question 67, answer'd by Mrs. Hefychia.*

Guineas ten, forty-four, and seventy-eight,
 (As I do take it) set the matter right;
 An hundred and five, sixty-two, nineteen,
 Are all the pistoles to answer each guin.

† IV. *Question 68 answered.*

The verfed fine's length 28.2055 feet.

V. *Quest.*

* III. QUESTION 67 *solved.*

Put x and y for the number of guineas and pistoles respectively, then the number of six-pences in them being $43x$ and $34y$, and the six-pences in 100*l.* = 4000, we shall have $43x + 34y = 4000$; hence $x = \frac{4000 - 34y}{43} = 93 - \frac{34y - 1}{43} =$ a whole number; consequently $\frac{34y - 1}{43}$ as also 5 times the same, viz. $\frac{170y - 5}{43} =$ a whole number; take this from the whole number $\frac{172y}{43} = 4y$, and there remains the whole number $\frac{2y + 5}{43}$; from 12 times this whole number, viz. $\frac{44y + 110}{43}$, take the whole number $\frac{43y}{43} = y$, and there remains the whole number $\frac{y + 110}{43}$, which put = p ; then $y = 43p - 110$, where the least value of p is evidently 3. Substitute this value of y in the value of x , and we shall have $x = \frac{4000 - 34y}{43} = 180 - 34p$, in which the greatest value of p is evidently 5. So that the question admits of only three solutions, p having only three values, viz. 3, 4, and 5; and by writing each of these numbers for p in the values of x and y , we obtain $x = 78, 44, \text{ and } 10$, and $y = 19, 62, \text{ and } 105$.

† IV. QUESTION 68 *solved.*

The right fine being 30, and verfed fine 10, by the nature of the circle, the diameter will be $10 + \frac{30^2}{10} = 100$, and consequently the radius = 50. But, by right-angled triangles, the cosine of the arc whose right fine is 45, will be $= \sqrt{50^2 - 45^2} = 5\sqrt{10^2 - 9^2} = 5\sqrt{19} = 21.7944947$ &c. which being taken from the radius 50, there remains 28.205505 &c. for the verfed fine required.

* V. Question 69 answered.

In the 9th line of this quest. the error of [not] instead of [in] quite alter'd the design; otherwise the answer had been,

A's part 96'65864 pounds

E — 25'19722

Y — 58'14413

† VI. Quest. 70, answer'd by Mr. John Finch, of Norwich.

As rad. : to S. giv. angle :: $\frac{1}{2}$ the rectang. giv. : to area
4 a. 1 r. 9 p.

VII. Quest.

* V. QUESTION 69 solved.

By the right-angled triangles, the distance between the focus and the end of the conjugate will be $\sqrt{20^2 + 15^2} = 25$ = the semi-transverse by the nature of the ellipse; then, by case 2 p. 225

Mensuration, $25 - \frac{25 \sqrt{20^2 - 15^2}}{20} = 25 - \frac{25 \sqrt{4^2 - 3^2}}{4} =$

$25 - \frac{25 \sqrt{7}}{4} = 8.4640543$ &c. = the abscissa of *E*'s part.

Now $\frac{8.4640543}{50} = .169281$, and $\frac{18}{50} = .36$; but the tabular areas for these two quotients, in the table of segments at the end of my Mensuration, are .08799586 and .25455055, whose sum taken from .78539816, there remains .44285175. Also the product of the two axes = $50 \times 40 = 2000$.

Then, by rule 2 p. 244 Mensur. we shall have

.08799586 × 2000 = 175.99172 = <i>E</i> 's part	} in square chains;
.25455055 × 2000 = 509.10110 = <i>Y</i> 's part	
.44285175 × 2000 = 885.70350 = <i>A</i> 's part	

their sum being 1570.79632 = .78539816 × 2000 = the area of the whole ellipse.

Also, by proportion, we have as 1570.79632 : 180 l.
 { 175.99172 : 20.1672 l. = 20 l. 3 s. 4 d. 0.512 q. = *E*'s money,
 :: 509.10110 : 58.3387 = 58 6 9 1.152 = *Y*'s,
 { 885.70350 : 101.4941 = 101 9 10 2.336 = *A*'s.

180 0 0 0 sum.

So that the numbers in the original solution are false.

† VI. QUESTION 70 solved.

By a known rule for the area of a triangle, we have as 1 : .510793 (the nat. sine of 30° 43') :: 84.375 = half the product of the including sides : 43.09817 chains = 4 a. 1 r. 9.5707 perches.

* VII. *Question 71, answered by Mr. Nath. Brown, writing-master at Sleaford, in Lincolnshire.*

$$\begin{array}{l} \text{Length } 30 \\ \text{Breadth } 15 \\ \text{Depth } 12 \end{array} \left. \vphantom{\begin{array}{l} 30 \\ 15 \\ 12 \end{array}} \right\} \text{ inches without } \left\{ \begin{array}{l} 23'777 \\ 11'888 \\ 9'511 \end{array} \right\} \text{ within.}$$

† VIII. *Question 72 answered.*

The men were 99, and had 99 l. each. The whole 9801 l.

IX. *Quest-*

* VII. QUESTION 71 *solved.*

Put x, y, z for the length, breadth, and depth of the stone respectively: Then, by the question, $x + y + z = 57$, and $xyz = 5400$. The question then is unlimited, there being one equation less than the number of unknown quantities. We shall therefore assume another condition, viz. we shall suppose the length to be double the breadth, or $x = 2y$: Then, this written for it in the two given equations, we have $3y + z = 57$, and $2y^2z = 5400$.

Hence $z = 57 - 3y$, which written for it in the last equation, we have $114y^2 - 6y^3 = 5400$, or $19y^2 - y^3 = 900$. Here $y = 15$. Consequently $x = 2y = 30$, and $z = 57 - 3y = 57 - 45 = 12$.

Then, since 5 pecks = $10 \times 268.8 = 2688$ inches, and similar solids are as the cubes of their like sides, we shall have as $\sqrt[3]{5400}$: $\sqrt[3]{2688}$ or as $\sqrt[3]{225} : \sqrt[3]{112}$ or as $\sqrt[3]{3375} : \sqrt[3]{1680}$, that is, as

$$15 : 2\sqrt[3]{210} :: \left\{ \begin{array}{l} 30 : 4\sqrt[3]{210} = 23'77568 \\ 15 : 2\sqrt[3]{210} = 11'88784 \\ 12 : \frac{8}{3}\sqrt[3]{210} = 9'51027 \end{array} \right\} = \text{the dimensions}$$

of the hollow.

† VIII. QUESTION 72 *solved.*

Put x for the number of pounds in the chest: Then, by the question, $1 + \frac{x-1}{100} = \frac{99+x}{100}$ = the first man's share, and con-

sequently the sum afterwards left = $x - \frac{99+x}{100} = \frac{99x-99}{100}$;
again,

* IX. *Question 73 answer'd by Mr. Tho. Fletcher.*

Most readily, sir, I'll the number divulge,
Which the margin makes plainly appear. 2520
I'll the canon reserve till I taste of your wine:
Pray observe, I'm schoolmaster of Ware.

Mr. *Naughley* gives this canon; multiply the highest given powers together, and their products continually by every such given prime, as is no component of any of the said powers, or their product, or of any other given prime: So $9 \times 8 \times 7 \times 5 = 2520$ required.

X. *The*

again, the 2d man's share will be $2 + \frac{99x - 99}{100} =$
 $198 + \frac{99x - 99}{100} = \frac{19701 + 99x}{10000}$, which must be = that of
 the former, that is, $\frac{99 + x}{100} = \frac{19701 + 99x}{10000}$; hence $9900 + 100x$
 $= 19701 + 99x$, and $x = 19701 - 9900 = 9801 =$ the num-
 ber of pounds in the chest. And $\frac{99 + x}{100} = 99 =$ each man's
 share.

Again, putting $z =$ the number of men, by the question it will
 be $z + 99 = 4 \times 9801$; hence, by extracting the root, $z + 99$
 $= 2 \times 99$, and $z = 99 =$ the number of men the same with the
 number of pounds in each man's share.

* IX. *QUESTION 73 solved.*

The general rule for this kind of questions, is to begin with the greatest number and descend gradually to the least, taking the continual product of them; but omitting such of the less numbers or of their factors as are factors of any of the greater ones. So, in this example, 9 must be used as being the highest number; 8 must be used because neither itself nor any of its factors 2, and 4, are factors of 9; 7 must be used because it is no factor either of 9 or 8; 6 must be omitted because one (3) of its factors divides 9, and the other (2) divides 8; 5 must be used as being no divisor of either 7, 8, or 9; but 4 must be omitted as being a factor of 8, 3 must be omitted as being a factor of 9, and 2 omitted as being a factor of 8. The reason of all which is extremely obvious.

Then $9 \times 8 \times 7 \times 5 = 2520 =$ the least number required.

* X. Question 74 resolved by Mr. T. Hill.

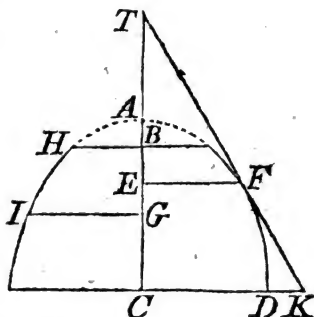
As you are Crabb by name, I think by nature too,
I your crab do taste at last, but 'tis with much ado.

The content of the cylinder 182'2503, of the cube 84'2645;
the difference in wine gallons 97'9858.

The

* X. QUESTION 74 solved.

Let CB be half the length of the cask, CE and CG half the height of the cylinder and cube respectively; draw the ordinates EF , GI , and to the point F draw a tangent meeting the semi-transverse CA , and semi-conjugate CD , produced, in T and K .



Then, by p. 209 Simpson's Geom. 2d edit. the sub-tangent is twice the altitude of the greatest cylinder, that is, $ET = 2EG$; hence $CT = 3CE$, and $CK = \frac{1}{2}EF$: but, by the nature of the ellipse, $\{CE : CA :: CA : CT \text{ or } 3CE\}$ hence $CE = CA\sqrt{\frac{1}{3}}$, and $EF^2 = \frac{2}{3}CD^2$: but, also by the ellipse, $\sqrt{CD^2 - BH^2} : CB :: CD : CA = \frac{CD \times CB}{\sqrt{CD^2 - BH^2}}$; and

therefore $CE \text{ (or } CA\sqrt{\frac{1}{3}}) = \frac{CD \times CB}{\sqrt{3CD^2 - 3BH^2}}$. Hence the solidity of the whole greatest cylinder will be $2CE \times EF^2 \times 3.14159 \text{ \&c.} = \frac{4CD^3 \times CB}{\sqrt{3CD^2 - 3BH^2}} \times \frac{3.14159 \text{ \&c.}}{3} =$

$$\frac{203 \times 26.4 \times 4}{\sqrt{3.20^2 - 3.15^2}} \times \frac{3.14159 \text{ \&c.}}{3} = 42100.05.$$

Again, CG being half the side of the cube, and GI the radius of a circle circumscribing one face of it, the square of the side of the cube or $4CG^2$ will, by right-angled triangles, be $= 2IG^2$; and hence $IG^2 = 2CG^2$: but, by the ellipse, $CA^2 : CD :: CA^2 - CG^2 : GI^2 \text{ or } 2CG^2$; hence $\sqrt{2CA^2 + CD^2} : CD :: CA : CG = \frac{CA \times CD}{\sqrt{2CA^2 + CD^2}}$ (by writing the value of CA

Diary Math.

R

instead.

The Prize Question answered by Mr. Whitworth.

Put $b = 13$, $c = 16$, $l = 18$ the length, $d = 269$ the content, $g = .78539$ &c. a = lesser base's diam. Then $b : c :: a : \frac{ca}{b}$ = greater base's diam. Now the area of the greater base, lesser base, and a geometrical mean multiply'd by $\frac{l}{3} = d$, the content, that is $aag + \frac{ccaa}{bb} + \frac{aagc}{b} \times \frac{l}{3} = d$, which reduced is $ccaa + bbaa + bcaa = \frac{3dbb}{gl}$: by this equation

instead of it) $\frac{CD \times CB}{\sqrt{CD^2 + 2CB^2 - BH^2}}$; whose cube is $\frac{20^3 \times 26.4^3}{20^2 + 2.26.4^2 - 15.9^2} = 19464.41$ = the content of the cube.

The difference of these two contents is 22635.64 inches = 97.9898 wine gallons = the difference required.

* PRIZE QUESTION solved.

Putting $16x$ and $13x$ for the diameters of the ends of the conic frustum, and $n = .785398$ &c. by cor. 6 p. 156 Menfur. we shall have the content of it = $16 + 13^2 - 16.13 \times x^2 \times \frac{18n}{3} = 269$

by the question; hence $x = \sqrt{\frac{269}{29^2 - 16.13 \times 6n}} = \sqrt{\frac{269}{633 \times 6n}} = .3002989$. Therefore $16x$ and $13x$ become 4.8047824 and 3.9038857 for the diameters of the hole.

The greater diameter drawn into 4 and 3 give 19.2191296 and 14.4143472 for the diameter at the middle and ends of the nave; and consequently its solidity including the hole will be $\frac{14.4143472^2 + 2.19.2191296^2}{3} \times \frac{18n}{3} = 4460.386$; from which taking 269 the content of the hole, there remains 4191.386 for the quantity of the solid.

Also, by the nature of the ellipse (see the last fig.) $CB^2 : CG^2 :: CD^2 - BH^2 : CD^2 - GI^2$; and hence $2GI = 2\sqrt{\frac{CB^2 \cdot CD^2 + CG^2 \cdot BH^2 - CG^2 \cdot CD^2}{CB^2}} = 17.8745048$ (CB being 9 and $CG = 5$ by the question); which multiplied by 3.14159 &c. we have 56.15441 for the circumference of the hoop.

equation $a = 3^{\circ}903886$ the lesser base of the cone's frustum, and $\frac{ca}{b} = 4^{\circ}804782$ the greater base's diameter; whence the

greatest thickness of the nave is	—	—	19°219128
Each end	—	—	14°414346
The solidity of the frust. the cavity subt.	—	—	4191°408136
The diameter 4 inches from the end	—	—	17°874505
Circumference	—	—	56°154402

The lot for the prize fell to *Philomathematreæ*.

Of the Eclipses in 1720.

There can happen but two eclipses this year, and both of the sun, but invisible to the inhabitants of our British islands. One of them is before the sun's apogæon, and the other after; so that the earth's shadow, and her atmosphere, are incapable of eclipsing the moon.

1. Sun eclipsed the 28th of january, near 11 in the forenoon, at which time the moon's latitude is so much south, that the shadow will be depreſs'd too far to be ſeen by us.

2. Sun eclipsed the 23d of july; about 3 o'clock in the morning, but ends ere the sun is riſen.

The total eclipse of the moon the 29th of august, 1718, I observed near Chateſworth, in Derbyſhire: the beginning of total darkneſs 53 min. paſt 6, the end of total darkneſs 45 min. after 8 o'clock, the full end of the eclipse 48 min. after 9 at night.

Mr. *John Child*, at Kingſthorpe, near Northampton, in Latitude $52\frac{1}{4}$, observed the end of the eclipse 9 h. 50 min.

Adraſtea, of Wirkſworth, in Derbyſhire, ſent me the calculation of the moon's eclipse on the 18th of august, 1719, performed by her own hand from the Caroline Tables; and altho' the eclipse will be over before this diary is published, yet I ought to acknowledge the favour by committing the reſult of her calculations to the preſs.

	h.	'	"
The equal time of the greateſt obſcuration	8	29	6
Equation of time ſubtract	—	14	3
Remains the apparent time of the greateſt obf.	8	15	3
Time of half duration ſubtract	—	58	0
Remains the beginning of the eclipse, evening	7	17	3
Semi-durat. add, gives the end of the eclipse	9	13	3
Duration 1 ho. 56 min. digits eclipsed 3 d. 13 m.			

R 2

Since

Since there is no visible eclipse this year, 1720, I shall here infer one of the moon, which happens in the ensuing year 1721, the 22d of december.

Just as I received it in manuscript from the same ingenious gentlewoman.

			d.	h.	m.	s.
The mean 8 22d december, 1721	—	—	22	4	7	2
Difference from the 8 parts	—	—			45	52
Hourly motion of ☉ 2' 33" of ☽ 30' 7" dif.					27	34
Interval of mean and true 8 sub.	—	—			1	33 18
The middle time of the 8	—	—	22	2	33	42
Anomaly ☉ 6. 4. 15. 58. Anomaly ☽	—	—	11	19	27	0
☉'s place in ♍	—	—	9	11	46	47
The moon's place in the ecliptic ☾	—	—	3	11	57	17
The place of dragon's head sub.	—	—	3	11	36	36
Arguments of latitude	—	—			20	41
Reduction 5" subtr. latitude of ☽ north	—	—			1	44
Difference of hourly motions	—	—			27	36
Reduction contrary to the title add	—	—			11	
Correct equal time in the ecliptic	—	—			2	33 53
Reduct. subtr. greatest obscuration	—	—	22	2	33	31
Equation of time add	—	—			3	38
Apparent time at London	—	—			2	37 9
Difference of meridians subtract	—	—			6	
Apparent time at Wirksworth	—	—	22	2	31	9
Half duration	—	—			1	51 40
Beginning of the eclipse	—	—			XII	39 29
End of the eclipse, evening	—	—			III	22 49
Lat. ☽ at begin. 5' 14" fou. at the end nor.					6	33

This eclipse is total to the eastern inhabitants, but with us will not, because the ☽ rises not till the greatest part is expir'd; she appearing then about 6 digits darkened.

— Et fecunda facit pectora laudis amor.
Vivitur ingenio; cætera mortis erunt.

P.S. Near Beighton, in Derbyshire, the 18th of august, 1719, I observed the moon's eclipse about 3 digits 18 min. darkened on her north limb at 26 minutes after 8, and the end at 20 min. after 9, being in duration something longer than the former calculation of mine.

Paradoxes to be answered next year.

1. There is a certain people in South America, who are properly furnish'd with only one of the five senses, viz. that of touching; and yet they can both hear and see, taste and smell, and that as nicely as we Europeans, who have all the five.

2. There is a certain place on the continent of Europe, where if several of the ablest astronomers the world now affords should nicely observe all the celestial bodies, and that at the same instant of time; yet the planetary phases, and their various aspects, would be really different to each of them.

3. There is a certain European island, the northermost part whereof doth frequently alter both its longitude and latitude.

4. There are two distant places of the earth lying under the equinoctial line, whose difference of longitude is completely 36 degrees and a half; and yet the true distance between these two places is not full 86 Italian miles.

Paradox 5, by Mr. C. Mason.

Leander to his Hero writ; and she
As oft writ back to shew her constancy:
When with them both the post three times had been,
They had no more than each a letter seen.

New Questions.

I. *Question 73, by Mr. Tho. Dodd, Apr. 30, 1720.*

At Michaelmas last, seventeen hundred nineteen,
My writings will shew, which are yet to be seen,
That to me were three hundred and twenty pounds due:
And half of that sum, besides forty-two,
Just five years after that I might demand;
But would fain have the whole somewhat sooner in hand.
I agree to rebate for the latter sum too, * *Simp. interest.*
At the same rate of interest * our commons allow;
And I likewise expect some use will accrue,
For my sixteen score pounds, that last year were due.
Now to know on what day, I should be very fond,
To receive my five hundred and twenty-two pound.

R 3

II. *Question*

II. *Question 76, by Mr. W Crabb.*

If the side of the face of each body platonic
 Be twenty-nine inches, as you may project;
 Then good Mr. Gauger, now try to unfold,
 How many wine 'gallons each body will hold?
 And to this our author the same do impart,
 And you'll oblige those that are lovers of art.

III. *Question 77, by Mr. W. Deare.*

Upon a friend's request, the other day,
 A field triangular I did survey;
 The longest side, save one, is just 8 chains,
 Six score degrees the angle blunt contains,
 From which a perpendicular let fall
 Upon the base, th' alternate * segment shall
 Be $5\frac{1}{11}$ chains. Explore, I pray,
 The other segment, side, and area?

* Segment or base next the side required.

IV. *Question 78, by Mr. G. Hare.*

Suppose a plane in latitude fifty-three
 Decline, and shou'd recline, as here you see,*
 In what latitude shall that plane become
 An upright? and what declination
 Shall this plane have, in that latitude?
 And what angle shall the meridian
 In such a plane make with the horizon.
 Style's height and distance also let me see,
 What will substile from meridian be?
 As also show, where the hour lines will fall
 By calculation arithmetical?

* North-west decl. $43^{\circ} 15'$, reclin. $49^{\circ} 10'$.

V. *Question 79, by Mr. John Ashton.*

As I with some ladies was drinking of tea,
 The weather was pleasant, and the first day of May;
 I happen'd t' applaud their brisk genius and wit,
 Yet thought mathematics for them not so fit;
 But nettl'd at this was a learned brisk lass,
 And sun shining plain on a specular glass,
 To th' top o'th' east corner of the room came the rays;
 I et's see by your learning? She answering prays;

T

This glass is i'th' middle o'th' wall I do find,
 Horizontally plac'd, which stands to th' south wind.
 The area o'th' end of the room I here show, [80 foot]
 The whole room's dimensions from hence I would know,
 With the time of the day? But I'll tell you below,
 That the height of the sun is exactly the same,
 As azimuth, I truly do find by the beam.

A dish of the best shall then be your due;
 But, ladies, the point I refer unto you,
 Since your sex propos'd it, pray tell it me too.

VI. *Question 80, by S. T.*

A vacuum in the earthly globe suppose,
 Extended to the superficies close:
 Then grant that we above a river have
 Of constant course, and swift unalter'd wave:
 Twelve yards its breadth; but six its depth do show;
 A thousand yards an hour it runs; and so
 It falls into the vacuum below.
 Its time to fill it up, pray let me know?

VII. *Question 81, by Mr. J. Jennings.*

A house (suppose) was bought and also sold,
 Whose cost exceeds its gain, as I am told,
 One hundred and sixty pounds in gold.
 Their squares together added, will amount
 Unto the sum * annex'd. Pray, ladies, count
 What is the cost, and also what the gains:
 Which if you do, I'll thank you for your pains.

VIII. *Question 82, by Mr. William Doidge.*

As I was walking on a summer's day,
 Thinking to drive the tedious hours away;
 I saw a cone, whose vertex from the ground,
 Upon the slant, just sixty feet I found.
 The true contents of its solidity,
 Are thirty thousand feet and sixty-three;
 The perpendicular height o'th' cone to find,
 All means I've us'd; 'twill sure distract my mind.
 Assistance, ladies, I most humbly crave:
 I pray, from ruin do your servant save.

IX. *Questio*

IX. *Question 83, by Mr. J. Plomley or N.M.*

From the high cross in Bristol two men once set out,
 Resolving to travel the whole world about:
 The one direct easterly steering his way;
 The other went north, as some people do say:
 The first travell'd 7 miles $\frac{455}{11111}$ every day,
 The other $11\frac{143}{1111}$: But now I you pray,
 How many times round the world must they go?
 And how many * miles will each travel also?
 And how many days must they be to obtain,
 To meet at the cross afore said again?

* *Reckoning 360 degrees, each 60 English miles vulgar computation.*

The Prize Question; the answerer may by lot win 10 of these diaries.

With heads full of ale, joke, pun, and banter,
 Two young tyros, who'd talk'd much of Gunter,
 Euclid, and Barrow, fell to squabble of arts,
 Being confident each of his own brighter parts,
 I'th' Cyclopædia agreed as a proof,
 To find the contents of an old kneading-trough;
 Whose bottom was turn'd up on this occasion,
 To serve as a table, in their potation.
 The guinea lugg'd out, a wager was laid,
 And into the hands of their landlady paid.
 Both fell to scrawling, each sure of the matter;
 But disagreeing, chose me arbitrator:
 And with the dimensions they to me came post;
 But when they came in, in good sooth they were lost:
 No matter, says one, we shall do well enough,
 I remember, five-thirds o'th' breadth of the trough
 Reach'd cross the bottom as a diagonal line,
 From the bottom's edge to the upper edge or brim.
 Also the sides, ends, and bottom are all
 One breadth. — Says t'other, I have not forgotten
 1175 feet is the perimeter at bottom,
 And the area is just one half of that sum
 In square feet and parts (as sure as a gun).
 Now, sir, we request you, from this number given,
 To find that part's contents o'th' trough, if set even
 Or level—to the diagonal line?
 And how many gallons it will hold in wine?
 And also the whole trough's vacuity
 In inches: — pray tell me how many they be?

The

1721.

The Author's Preface.

ALthough learning, and the mathematical sciences, have never wanted the defence of many excellent pens, and met with the highest applause, thro' all ages, and (most) countries in the known world; yet we often find men of so base a spirit, that either from the height of ignorance, or envious spleen, they still dare to despise 'em.

Ars nullum habet inimicum nisi ignorantem.

But most generally their envy is levell'd at the female sex, for (say they) learning makes a woman proud and impertinent; 'tis not the business of their sex: the management of their families, and religion, ought only to be their study. But for my part, I cannot see that the search after truth and reason, the improvement of the mind, and duly rectifying the judgments, by those rules, and unerring opinions, of the wisest men, should any more conduce to the bringing a woman into errors, than the search after virtue should be thought the only way to teach us vice. Nor can I conceive, that a woman who does mathematically demonstrate, *that the whole is equal to all its parts*, or 2 and 2 make 4, is less capable of managing her household, governing her servants. and giving her children due education.

Nor will she be the less a christian, for understanding the system of the universe; but on the contrary, admire that infinite wisdom in the Creator, who alone could make and govern things so vastly surpassing our comprehension. On the other hand, it might as well be said, he who understands Horace and Virgil, is incapable to manage his estate; or because he understands geometry and mathematics, he is unfit to plow, sow, or buy and sell the products of the same. Whoever should assert these things, must by all the world be thought guilty of the greatest madness or stupidity. Ignorance never sets a value on any person, but has always been found a constant attendant on self-conceit and impudence; when learning is the way to modesty and good manners. Ignorance is for ever incapable of knowing and doing right; but knowledge like a diamond polished, more illustriously shines.

Stationers' Hall, London,
the 4th of august, 1720.

Paradoxes

Paradoxes answered.

First Paradox answer'd.

All the senses are properly by the touch; in seeing, the object touches the retina; hearing, the sound touches the drum of the ear; smelling, the effluvia touch the sensorium; tasting, the palate, &c.

Second Paradox answer'd.

Neither at the center, nor any part of the earth, can any one observe all the celestial bodies at one and the same instant of time.

3d. This is meant a floating island, removing by the sea.

4th. The places are not suppos'd on the surface of the earth, but nearer to the center, where the longitudes all coincide.

The 5th par. means, with both, not each 3 times; the post first took Leander's letter, 2d Hero's answer, 3d brought it to Leander.

Solutions to the questions.

** I. The 75th Question answer'd.*

The author's solution is, the payment must be April 30, 1721.

II. *The*

** I. QUESTION 75 solved.*

The sum 320*l.* being due the 29th of September, and the other sum 202*l.* due just 5 years afterwards; the meaning of the question is to find such a day between these two times, as that the whole sum 522*l.* being then received, neither the receiver nor deliverer may suffer any loss; in which case it is evident that the interest of the 320*l.* for the time it is kept beyond the time when it was due, must be equal to the discount of the 202*l.* for the time it is received before it is due.

Hence

* II. *The 76th Question answer'd by Mr. Dodd.*

The wine that each body platonic will hold,

In the numbers annex'd, is demonstrably told.

The dodecaedron, so much does contain, 809'072 *W. gall.*

The icosaedron will hold, it is plain; 230'343

Hexaedron's content, in this number I shew, 105'38

Thus much the octaedron affords unto you; 49'77

Divide the last sum exactly by 4,

Tetraedron that quantity holds, and no more. 12'442

III. *The*

Hence then, denoting the time for the discount by x , and consequently the time for the interest, or till the whole must be paid, by $5 - x$; by the rules for interest and discount, $320 \times \frac{5}{100} \times 5 - x = 16 \times 5 - x$ will be the interest of 320 for the time $5 - x$, and $100 + 5x : 5x :: 202 : \frac{202x}{20 + x}$ = the discount of 202 for the time x , the rate of interest being 5 per cent. Consequently $16 \times 5 - x = \frac{202x}{20 + x}$; hence $x^2 + 27\frac{2}{5}x = 100$, and $x = 3.239888$. Wherefore $5 - x = 1.76$ years nearly = 1 yr. 277 days; which being added to Sept. 29, we have the 3d of July 1721 for the day of payment.

* II. *QUESTION 76 solved.*

By page 404 &c. of my *Mensuration*, it is found that the solidities of the five regular bodies, the side of each face being 1, will be thus:

Tetraedron	=	0.11785113
Hexaedron	=	1.00000000
Octaedron	=	0.47140452
Dodecaedron	=	7.66311896
Icosaedron	=	2.18169499.

Then, since similar solids are as the cubes of their like sides, each of these numbers being multiplied by 24389 the cube of 29, the products will be the contents of the bodies in inches; and if these contents be divided by 231, the inches in a wine gallon, there will result the several numbers of gallons as in the original solution.

- * III. *The 77th Question answer'd by Mr. Crabb, Mr. Allen, Mr. Failes, Mr. Chorley, Mr. Finch, Mr. Gurney, Mr. Dodd, and Mr. White.*

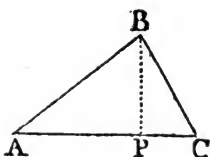
24'2787 chains = 2ac. 1 ro. 28 per.

IV. *Question*

* III. QUESTION 77 *solved.*

In this question are given the vertical angle, one side, and the alternate segment of the base; viz. the angle $ABC = 120$ degrees, $BC = 8$ chains, and $AP = 5\frac{1}{7}$ chains.

Put $a = BC = 8$, $b = AP = 5\frac{1}{7}$, $s = \frac{1}{2}\sqrt{3}$ sine of the angle ABC or 120° , and $z = PC$. Then, by right-angled triangles, $BP = \sqrt{a^2 - z^2}$, and $AB = \sqrt{b^2 + a^2 - z^2}$; $AB \times BC \times \text{fine } \angle B = \text{twice the area} = BP \times AC$, that is, $as\sqrt{b^2 + a^2 - z^2} = b + z \cdot \sqrt{a^2 - z^2}$; and this, by squaring both sides, and writing the numbers instead of the letters, becomes $48 \times 16745 - 169z^2 = 77 + 13z^2 \times 64 - z^2$, which will be an equation of the 4th order; and by expanding it out, the root z may be found by converging series. But the root will be much easier found by the method of Trial and-Error, from the equation as it here stands; and by this method z will come out 7.077 or $7\frac{1}{7}$. Hence the base AC is 13 , and the area $24\ 248$ square chains.



Scholium.

This problem is the same as to divide a given angle into two parts such, that the tangent of the one may be to the secant of the other, in a given ratio.

* IV. *The 78th Question answer'd by Mr. Hawney, Mr. Failes, Mr. White, Mr. Williams, and Mr. Finch.*

h.	equin.	h. dist.
	° ' ° '	
VIII	140 9	143 12
IX	125 9	128 20
X	110 9	112 24
XI	93 9	84 18
XII	80 9	78 56
I	65 9	62 33
II	50 9	46 53
III	35 9	32 7
III	20 9	18 8
V	5 9	4 36
	Sub—	Stile E.
VI	9 51	8 48
VII	24 51	22 26
VIII	39 51	36 38

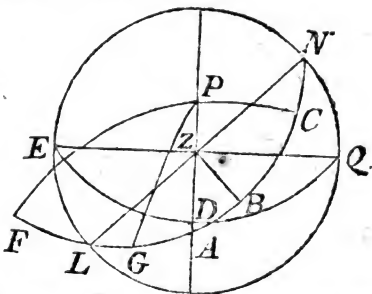
V. *Question*

† IV. QUESTION 78 *solved.*

* The meaning of this question is, that supposing in the latitude of 53° (north) a plane to face the north-west quarter, making an angle of $43^{\circ} 15'$ with the west line, and reclining backward towards the south-east quarter $49^{\circ} 20'$, if this plane be moved along the same meridian continually parallel to its first situation, till it becomes an upright plane; to find then the proper requisites for a dial to be described on it.

Construction.

Let ELQ_N be the horizon and Z the zenith of the place in lat. 53° , P the pole, LZN the position of the plane making the angle $EZL = 43^{\circ} 15'$, EZQ being the prime vertical, $PZDA$ the meridian, and EDQ the equinoctial. Perpendicular to LN draw ZB equal to $49^{\circ} 20'$ the reclination, and draw the great circle $LABN$, which will be the plane of the dial, A being the new



Diary Math.

S

place

V. *Question 79 answer'd.*

This question was imperfectly propos'd, no lat. being fixed, so answers may vary for different places. The proposer, in

place required; also draw the great circle or meridian CPF perpendicular to $NALF$.

Then DA will be equal to the new latitude south; in which the plane will be upright, the angle ZAB the co-declination, AF the distance of the substile from the meridian, PC the stile's height, AL the distance of the meridian and horizon, and the angle APF the plane's difference of longitude.

Calculation.

1. In the right-angled triangle ABZ , given ZB the reclination $= 49^\circ 20'$, and $\angle AZB$ the declination $= 43^\circ 15'$. Then

As $\text{Cof. } \angle AZB = 43^\circ 15' : \text{Radius} :: \text{Tang. } ZB = 49^\circ 20' : \text{Tang. } AZ = 57^\circ 58'$; from which taking $ZD = 53^\circ$, there remains $DA = 4^\circ 58'$ the new latitude.

As $\text{Radius} : \text{Sine } \angle AZB :: \text{Cof. } ZB : \text{Cof. } \angle A = 63^\circ 29'$, whose complement $26^\circ 31'$ is the new declination.

As $\text{Radius} : \text{Sine } ZB :: \text{Tang. } AZB : \text{Tang. } AB = 35^\circ 31'$ the complement of $54^\circ 29'$ the dist. of merid. and horiz.

2. In the right angled triangle AFP , are given $AP = 94^\circ 58'$, and $\angle A = (180^\circ - 63^\circ 29') = 116^\circ 31'$. Then

As $\text{Radius} : \text{Cof. } \angle A :: \text{Tang. } AP : \text{Tang. } AF = 78^\circ 59'$ the distance of the substile from the merid.

As $\text{Radius} : \text{S. } AP :: \text{S. } \angle A : \text{S. } FP = 116^\circ 57'$, whose supplement $63^\circ 3'$ is the stile's height.

As $\text{Radius} : \text{Cof. } AP :: \text{Tang. } \angle A : \text{Cotang. } \angle P = 80^\circ 9'$ the plane's diff. of longitude.

Now this $80^\circ 9'$, or plane's difference of longitude, shews that the distance, on the equinoctial DE , of the hour line PA of 12, is $80^\circ 9'$ from the substile PF ; and which is therefore set opposite to it in the table to the original solution. The equinoctial distances in the same column of the table, belonging to the other hours, are found by the continual addition and subtraction of 15° . And the several distances, on the plane of the dial, in the other column of the table, against the equinoctial distances, are all found by this proportion, As $\text{Radius} : \text{S. } 63^\circ 3'$ the stile's height $:: \text{Tang. of each equinoctial distance} : \text{Tang. of the corresponding distance on the plane of the dial}$. For if PG be any hour circle; then, in the right-angled triangle PGF , As $\text{Radius} : \text{S. } PF :: \text{Tang. } \angle P : \text{Tang. opposite side } FG$.

Note. In the table to the original solution, for the distance on the plane against the hour XI, the author has set $84^\circ 18'$ instead of its supplement; or rather indeed should be $95^\circ 46'$ the sup. of $84^\circ 14'$ as appears by calculation.

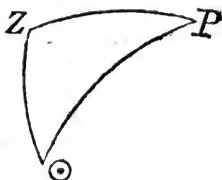
in latitude $53^{\circ} 28'$, as also Mr. *Crabb*, Mr. *Allen*, Mr. *Finch*, Mr. *Wah*, Mrs. *Dod*, and several others, answer.

Time of the day 2 ho. 6 min. altit. and azimuth $48^{\circ} 20'$, length of the opposite side of the room $7^{\circ} 29' 216$ foot, height $10^{\circ} 97'$, breadth of end walls $3^{\circ} 245'$, May 1, 1719, London.*

VI. The

* V. QUESTION 79 solved.

With the above original answer, supposing the latitude to be $51^{\circ} 32'$ that of London. Then, in the annexed figure, if *P* be the pole, *Z* the zenith, and \odot the sun; we have given $PZ = 38^{\circ} 28'$ the co-latitude, $P\odot = 72^{\circ} 6'$ the co-declination for May 1 old stile or May 12, new stile, and the supplement of the angle $Z =$ the complement of $Z\odot$; to find the hour angle *P*.

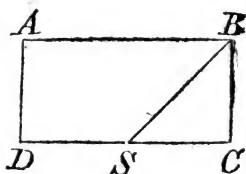


Put *a* and *b* = the sine and cosine of *PZ*, *c* = the cosine of $P\odot$, and *x* and $\sqrt{1 - xx}$ = the sine and cosine of $Z\odot$, or cosine and sine of the $\angle Z$.

Then, by common trigonometry, $axx + b\sqrt{1 - xx} = c$. Hence by completing the square and extracting the roots, we obtain $x = .6937742 =$ the cosine of $46^{\circ} 4'$ the altitude and azimuth. Also,

as s. $P\odot : s. Z :: s. Z\odot : s. P = \frac{x\sqrt{1 - xx}}{d}$ (putting $d = s. P\odot$) = $.5250344 =$ the sine of $31^{\circ} 40'$; which, at 15° to the hour, answers to 2 h. $6\frac{2}{3}$ min. afternoon.

Again, if *ABCD* represent the floor of the room, *S* the speculum in the middle of the south side *DC*, and *B* the east corner, and *SB* be drawn; then will the angle *B* be $= 46^{\circ} 4' =$ the azimuth from the south; also the triangle formed by *SB*, the height of the room, and the reflected ray, will be similar to the triangle *SBC*, because the altitude is equal to the azimuth. Wherefore, if *s* and *c* denote the sine and cosine of $46^{\circ} 4'$ the azimuth, or the sines of the acute angles of the said two triangles, and *z* the line *SB*; then will *SC* be $= sz$, *CB* $= cz$, and $c : s :: z : \frac{sz}{c} =$ the height of the room. Now, if the area of



S 2

the

* VI. *The 80th Question answer'd.*

In regard the diameter of the earth is variously computed; the answers to this must differ from one another accordingly: Mr. *Crabb* answers 1469,982,847,541 years, according to 60 miles a degree.

† VII. *The 81st Question answer'd.*

250 pound cost, and 90 gain.

VIII. *The*

the end *BC* be 80, then $\frac{sz}{c} \times cz = sz^2 = 80 = a$; hence $z = \sqrt{\frac{a}{s}} = 10.53$, and then the breadth $BC = 7.3123$, the length $DC = 15.1804$, and the height = 10.94.

But if the area of the side DC be 80; then $\frac{sz}{c} \times 2sz = \frac{2sz^2}{c} = a$; hence $z = \frac{\sqrt{\frac{1}{2}ac}}{s}$, and then the breadth = 5.075, the length = 10.536, and height = 7.5931.

* VI. QUESTION 80.

By the question, $6 \times 12 \times 1000 = 72000$ cubic yards of water run in an hour, or $72000 \times 24 \times 365\frac{1}{4} = 631152000$ cubic yards in a year. Now if the circumference of the earth be 21600 nautical miles, then $\frac{21600^3}{3.14159 \&c.^2 \times 6}$ nautical miles or $\frac{21600^3 \times 1760^3 \times 7^3}{3.14159 \&c.^2 \times 64}$ cubic yards will be the content of the earth; which being divided by 631152000, the quotient is 2334289000000 for the number of years required.

So that the first figure in the original answer seems to be falsely printed 1 for 2.

† VII. QUESTION 81 *solved.*

In this question, are given the difference of two numbers, and the sum of their squares, to find the numbers.

Put $d = 160$ the difference, $s = 70600$ the sum of the squares, and $x =$ the cost. Then $x - d =$ the gain, and $x^2 + x - d^2 = 2x^2 - 2dx + d^2 = s$. Hence $x = \frac{d + \sqrt{2s - d^2}}{2} = 250$ the cost, and $x - d = 90$ the gain required.

* VIII. *The 82d Question answer'd.*

The perpendicular height 55'5234 feet.

† IX. *The 83d Question answer'd.*

The first man travels 7 times round the globe, 151200 miles; the second, 11 times, or 237600 miles, and in 21535 days, or 59 years,

The

* VIII. QUESTION 82.

Put $a = 60$ the side, 30063 the content, and $z =$ the perpendicular height. Then the radius of the base will be $\sqrt{aa - zz}$, the area of the base $= aa - zz \times 3.1416$, and the content $= \frac{a^2 z - z^3}{3} \times 3.1416 = 30063$; hence $z = 55.52446 =$ the perpendicular required.

† IX. QUESTION 83.

It is evident that the number of times round each person travels, before they meet, will be directly as his rate of travelling. The question then only requires to be found the least two whole numbers that shall be in a given ratio; and such two numbers it is clear must be the least integer terms of the said ratio. Now the given terms of the ratio are $11\frac{14}{3307}$ and $7\frac{451}{21117}$ or $7\frac{21}{4107}$; and by dividing the former of these terms by 11, and the latter by 7, the quotient of each is $1\frac{1}{4107}$; therefore the least terms of the ratio are 7 and 11, and which of consequence give the number of times each travels round.

The Prize Question answer'd by Mr. J. Jope, jun.

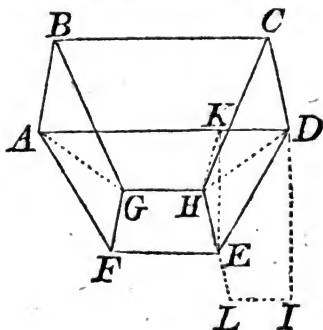
Length at top	5.591	The whole vacuity	18563.74
Breadth —	2.272	Vac. even with diag.	12156.85
Length at bottom	4.5969	Remaining part —	6406.89
Breadth —	1.2780	Liquor, 27.735 wine gallons.	
Depth —	1.1774		
Diagonal —	2.1300		

The prize of 10 diaries was won by Mr. Rich. Burnell of Dewsbury, in Yorkshire.

Of

* PRIZE QUESTION.

Let $ABCDEHGF$ be the trough, its depth DI , being a perpendicular from top to the bottom. Then by comparing the words of the question with this figure, the conditions will appear to be thus: Of the rectangle $EFGH$ the perimeter is 11.75, and the area = 5.875; $HE = EK = \frac{2}{3}$ of HK the nearest distance of GH from AD ; and HE, EK are also each = the distance between CD and HE , in consequence of which $EL = LI$ will be equal to the half difference of both the lengths and breadths at the top and bottom, and therefore the solid is a prismoid, and not the frustum of a pyramid: And it is required to find the whole content, as well as that of the wedge $ADEHGF$.



Now if x and y denote the length and breadth of the bottom, then $2x + 2y = 11.75$, and $xy = 5.875 = x + y$. From these equations we find $x = 4.597 = EF$, and $y = 1.278 = EH = EK$. And therefore $HK = \frac{3}{2} EH = 2.13$. Then in the obtuse isosceles triangle HEK , by Eucl. II. 12, $EL = LI = \frac{KH^2 - KE^2 - EH^2}{2EH}$

$$= \frac{\frac{9}{4}HE^2 - 2HE^2}{2HE} = \frac{1}{4}HE = .497 = \text{half the difference between the lengths and breadths; and whose double therefore being added to the length and breadth at bottom, we have } 5.591 = AD, \text{ and } 2.272 = DC, \text{ the length and breadth at top. Also, by}$$

Of the Eclipses in 1721.

In this year three times the sun and moon are within the bounds of eclipsing, at the conjunction; and three times the sun and moon in opposition, the earth will interpose and eclipse the moon.

1. Moon eclipsed January 2, the greatest obscuration at Coventry 16 min. after 3 in the afternoon, but the eclipse ends as the moon rises, so can't be seen.

2. Sun eclipsed Monday the 16th of January, at 8 o'clock at night, after sun-set, invisible.

3. Moon eclipsed Wednesday the 28th of June, 40 min. past 8 in the morning, the moon being then set, invisible.*

4. The fourth is a visible eclipse of the sun on Thursday the 13th of July, exactly at 8 in the morning.

	London h.	Coventry	London by Leadbetter	Coventry by Chatto ck
The beginning	VII 22	7 16	7 1	7 21
Visible conjunct.	VIII 7	8 1	7 45	8 2
Greatest obscur.	VIII 1	7 55	7 40	7 56
The end	VIII 36	8 30	7 21	8 32
Whole duration	I 13	1 13 $\frac{1}{2}$	1 20	1 17
Digits eclipsed	I 15	1 15	1 35	1 13

5. Sun

by right-angled triangles, $DI = KL = \sqrt{KE^2 - EL^2} = \sqrt{HE^2 - \frac{7^2 HE^2}{18^2}} = \frac{5 HE \sqrt{11}}{18} = 1.1774 =$ the depth of the vessel.

Then, by page 161 Menfuration, the content of the wedge $ADEHGF$ is $\frac{2EF + AD}{6} \times EH \times DI = 3.707873$ cubic feet or $= 6407.204$ inches $= 47.728$ wine gallons. And the content of the wedge $ABCDHG = \frac{2AD + GH}{6} \times DC \times DI = 7.034942$ cubic feet $= 12156.37$ inches. Also the sum of these two is 10.742815 feet $= 18563.57$ inches.

* The 3d eclipse on the 28th of June, was observed by Mr. Røpke at Harvard College in New England.

h.	m.	s.	
2	10	0	A thin penumbra.
2	12	0	The shadow is plainly entered.
3	18	30	Moon wholly covered.

5. Sun eclipsed December 8, at 1 in the morning, invifible.

6. Moon eclipsed Friday Dec. 22, total, and part vif. 2 ev.

The time at Wirksworth by } Adraſtea's calculation. }		Coventry by } Chattock }		London by } Leadbetter }	
	h. m.				
The begin. evening	XII 39	0	56	0	32
Begin. of total darkneſs	I 37	1	39	1	38
The middle —	II 33	2	30	2	27
End of total darkneſs	III 18	3	20	3	16
The end —	III 22	4	24	4	21
Whole duration —	3 43	3	48	3	49
Digits eclipsed —	20 48	20	39	20	17
D's lat. at begin. ſouth	5 10	2	50		
At the end north aſc.	6 30	7	0		E. M.

The moon will not riſe till near 4 o'clock, and the eclipse near done.

New Paradoxes.

1. There is a certain place in the iſland of Great Britain, where the ſtars are viſible at any time of the day, if the horizon be not o'ercaſt with clouds.

2. There is a remarkable river on the continent of Europe, over which there is a bridge of ſuch a breadth, that above three thouſand men abreſt may paſs along the ſame, and that without crowding one another in the leaſt.

3. There is a certain iſland in the vaſt Atlantic ocean, which being deſcry'd by a ſhip at ſea, and bearing due eaſt of the ſaid ſhip, at twelve leagues per eſtimation; the trueſt courſe for hitting of the ſaid iſland, is to ſteer ſix leagues due eaſt, and juſt as many due weſt.

4. A Paradox by Mr. J. Lumley.

The day that I was born, my father he
Laid by five pounds, and ſaid it was for me:
And when e'er my birth-day came, he never fail'd
To add five pounds (his love ſo much prevail'd):
At twenty-four, and upon my birth-day,
I wedded was, my portion he would pay:
Juſt thirty-five pounds; (I full twenty-four)
How comes it then my portion was no more?

New

New Questions.

I. *Question 84, by Mr. Sam. Dicker.*

Within Megora's city, thro' the wood,
 Call'd Jupiter's, t' th' castle Caria, stood
 Two small square temples; to Nyctelius Bacchus
 The one, the other t' Apostrophia Venus,
 Were dedicated; and their pavements laid
 With foot square stones; but Venus' temple stray'd,
 Each side thereof, exceeding Bacchus, lay
 Full twelve foot farther; but these pavements gay
 Contain two thousand six score stones: Pray tell,
 Each in its sep'rate length erected well.

II. *Question 85, by Mr. Moyle.*

'Twas in the pleasant month of May,
 The leaves were green, and flowers gay;
 The winds lay still, the air was clear,
 Only one cloud there did appear;
 Which I by observation found,
 Twenty degrees above the ground.
 In altitude bright Sol was then
 Above the cloud degrees fifteen;
 The shadow of the cloud, I found,
 Did from my station touch the ground,
 In yards exact, as e'er could be,
 The same you in the margin see. [2304 yards]
 This being known, to me declare,
 The cloud's height perpendicular.

III. *Question 86, by Mr. Jos. Dogharty.*

Three ships sail'd from a certain port to sea,
 To different ports, whose latitudes agree;
 Fifty-five leagues the first sail'd, south his coast.
 Th' others to coasts unknown, 'tween south and west;
 Till each arriv'd at his true destin'd post,
 When they asunder leagues fifty-seven were just:
 Angle * thirty-eight made. Whence they begun, * *Degrees*
 Pray tell me what the course, and distance run?

IV. *Question*

IV. *Question 87, by Mr. T. Williams, of Middleton-stoney.*

A friend did buy the other day,
 Some land, a new unheard-of way;
 I'th' latitude of fifty-two,
 And by the method here below.
 'Twas to be bounded by the shade
 That, March the tenth, a tall tree made,
 Betwixt the hours of eight and one;
 Therefore triangular when done.
 The topmost shade the base must show,
 And by the bodies the sides you'll know.
 One angle will be at the tree,
 In height one hundred feet and three.
 Now, sir, I've sent to you, for fear
 The sun should not that day appear;
 Pray shew the lengths and area clear.

}

V. *Question 88, by Mr. Chris. Harris.*

Suppose a polygon, of seven equal sides, were inclosed
 round about with shillings, each being an inch in the diame-
 ter; the shillings that reach round, just pays the purchase of
 what is inclos'd at this rate:

The shillings which do for one acre pay,
 Are eleven times the number of acres: Pray
 What number of acres inclosed must be,
 And the price of each acre pray let us see?

VI. *Question 89, by Adraſtea, who in it answers all the
 Enigmas in the laſt year's diary.*

In ancient times, when Minos kept his feat,
 Of law and juſtice, in the iſle of Crete;
 Then curious arts in infant drefs appear'd,
 And none of ſailcloth's mighty uſe had heard:
 Mechanic ſkill, ſcarce Muſhroom height could run, 91
 Which Winter froſt deſtroys, and Summer fun. 90
 Till Dædalus, accus'd of murder, came,
 Whoſe art affix'd a proverb to his name:
 A labyrinth he form'd, more intricate
 Than thoſe wherein Newcastle Coals they get; 2d Lat.
 In which himſelf and ſon were both confin'd,
 When glorious Reputation fir'd his mind. 97
 What hardſhips mortal men are born to feel,
 No Coach turns half ſo faſt as fortune's wheel. 1ſt Lat.
 Diſcord began in Candy's court to reign, 94
 An injur'd huſband can't forgive the queen;
 Nor

Nor those were privy to her guilty love,
 But Dæd'lus' arts must Dædulus remove.
 Some *Plumes* he got, drawn from the grey *Goose* wing, 95
 To makè a curious present to the king.
 Which pinion-wise, he fix'd unto his arms,
 And swiftly flew from the impending harms :
 Leaving Pasipha to bemoan her crime,
 Or with her *Thimble*, to beguile her time. 93
 While he in Cuma, to Apollo rais'd
 A splendid temple, where the god was prais'd.
 Had Icarus a sheet of *Pins* employ'd, 90
 When Sol's refulgent rays with wax he try'd,
 His fate severe, perhaps had milder been,
 And he once more, perhaps, his father seen.
 But where do poets rove? His wings were sails,
 Which Boreas' *Bellows* fill'd with speedy gales; 92
 And when immur'd, as a suspicious guest,
 Himself and others by their aid releas'd.
 Some malcontents, in number twenty-four,
 With specious promises his aid implore :
 Tell him, the charges they'll with joy defray,
 Name but the sum, and they'll the money pay.
 My cost, says he, is all that I demand;
 Twenty-four pounds, paid down, when next we land :
 But as you differ in your orders be,
 I'll have you to this method all agree;
 The captains each a certain sum shall pay;
 The captains' mates, each half as much as they;
 The common sailors, one-fourth part of that;
 Half a sailor's share must be each boy's lot.
 Now tell me, artists, how many there were
 Of every sort, and what was each one's share?
 For Cretans, fam'd for treachery and deceit,
 Deny'd their promise, and ne'er paid the debt :
 So after-ages may their fums rehearse,
 Or sing their numbers in heroic *Verse*, Prize.

VII. *Question 90, by Mr. Deare.*

A dying knight, in riches who abounds,
 Leaves an estate worth fifty thousand pounds :
 This for two hopeful children he designs,
 And that they thus divide it, them enjoins;
 The elder son the greater share must take;
 Which being squar'd, the square thereof will make
 A number equal to the younger's share,
 When multiply'd into the pounds that are
 In the estate. Their portions each declare.

VIII. *Question*

VIII. *Question 91, by Mr. C. Mason.*

An elliptical acre of grafs there is given,
 Whose length to its breadth is as nine is to seven;
 How long is the tether, and how brought to pafs,
 That a horfe fed no more than an acre of grafs?

*The Prize Question for 1721. The gardens of Alcineus,
 from the seventh book of Homer's Odyssey, translated by
 Mr. Pope.*

Close to the gates, a spacious garden lies,
 From storms defended, and inclement skies.
 Four acres was th' allotted space of ground;
 Fenc'd with a green inclosure all around.
 Tall thriving trees confefs'd the fruitful mold,
 And red'ning apples ripen here to gold.
 Here the blue fig with luscious juice o'erflows;
 With deeper red the full pomegranate glows.
 The branch here bends beneath the weighty pear;
 And verdant olives flourish round the year.
 The balmy spirit of the western gale
 Eternal, breathes on fruits untaught to fail.
 Each dropping pear, a following pear supplies;
 On apples, apples; figs on figs arise:
 The same mild season gives the blooms to blow,
 The buds to harden, and the fruits to grow.

Here order'd vines, in equal ranks appear,
 With all th' united labours of the year:
 Some to unload the fertile branches run,
 Some dry the black'ning clusters in the sun;
 Others to tread the liquid harvest, join.
 The groaning presses foam with floods of wine.
 Here are the vines in early flow'r descry'd,
 Here grapes discolour'd, on the sunny side,
 And there in autumn's richest purple dy'd.

Beds of all various herbs, for ever green,
 In beauteous order terminate the scene.
 Two plenteous fountains the whole prospect crown'd,
 This thro' the gardens leads its streams around,
 Visits the plants, and waters all the ground;
 While that in pipes, beneath the palace flows,
 And thence its current to the town bestows:
 To various use, their various streams they bring,
 The people one, and one supplies the king.

The

The king's pipe delivers the water ten foot and an half (English measure) below the surface of the water in the fountain, by an inch and three quarters bore: His brewing, once a week, takes fifty hogsheads of water, (wine measure) kitchen, landry, other offices, &c. five hogsheads a-day. The people have occasion for twenty hogsheads a-day; their cock, of two inches diameter, is below the fountain twenty-two foot. His majesty so much delights in a morning walk to see the waters undisturbed, that his orders are, that the cocks shall but run once every day, and that in the evening; so long only, as may supply next day's consumption, and for so much in his reservoir, as supplies his brewing each week. Then if the velocity or motion of the water be equal to that of an heavy body, acquired in these descents; and also, it be premised, that heavy bodies accelerate as the squares of their times, as sixteen foot the first second it falls, &c. How long every day ought each pipe to run, to give the king and people their due quantity?

A Dissertation on Engines.

Amongst the many useful inventions, those engines that are mov'd by the wind, water, horses, &c. such as mills, water-works for towns, gins, and machines for draining of mines, are not the least valuable; tho' generally very inartificially perform'd, more especially the latter.

It were much to be wish'd, they who write on the mechanical part of the subject, would take some little pains to make themselves masters of the philosophical and mechanical laws of (motion or) nature; without which, it is morally impossible to proportion them so as to perform the desired end of such engines. We generally see, those who pretend to be engineers, have only guess'd, and the chance is, they sometimes succeed; else they have made them like others that have done pretty well. But he who has skill enough in geometry, to reduce the physico mechanical part to numbers, when the quantity of weight or motion is given, and the force designed to move it, can bring forth all the proportions, in a numerical calculation, so as it may be almost impossible to err.

For was I to raise a certain number of hogheads of water in an hour, by a water-wheel, I must first find the quantity and velocity of my aquæduct, design'd for to fall on my wheel, from which I may proportion the diameter of my wheel; and such pumps, suckers, forcers, chains, or buckets; as that the force on my wheel may be so far superior to the weight of the columns of water to be raised, as it may be capable, by a certain number of revolutions in the hour, to fit my purpose, with due regard to the friction of the engine.

The following table I calculated in 1717, for a particular sort of engine; wrought by the pressure of the atmosphere, on the vacuum of an exhausted receiver; which is easily done 16 or 20 times a minute: the atmosphere pressing with a weight near 15 pounds avoirdupois, on every square inch contain'd in the surface of the piston or sucker, when the mercury stands at $29\frac{1}{2}$ inches (a medium) in the barometer. The ale gallon of 282 cubic inches weighs of pure water 10 pound 2 ounces avoirdupois. But to allow for frictions, and for a considerable velocity, each inch of the vacuum, experience tells us, will raise but about 3 pounds of water.

1722.

The Author's Preface.

Intellectual complexions have no desire so strong as that of knowledge; nor is any knowledge unto man more certain than the mathematical sciences: A study both useful and applicable to almost all the affairs of human life. For what business or discourse can we enter upon wherein quantity, time, or magnitude has not an immediate concern? By these we ought to model our arguments, as we would desire they should be clear, intelligible, and bear the test of the world: a thing I have observ'd almost generally neglected.

It has long been a maxim with me, *That any discourse, relation, or arguments, about quantity or measure, which agrees not to numbers, is in itself evidently false.* And since nothing can so regulate our minds to think and speak demonstratively, as the mathematical sciences, it may sufficiently justify my endeavours to introduce some few of both sexes to the study of them.

Providence has wisely design'd, that the sciences and arts severally have their votaries; and in what condition of life soever, each have their desires and objects fitted to them, whence springs their content and happiness in each state: but we generally observe, above all others, how equal is the distribution of wit, most being content with their share; though few with fortune. Amongst the most knowing parts of mankind, knowledge is more highly preferable than riches and vast possessions, by how much it distinguishes us above the brutes; which fortune only puts into a good pasture. If we are fallen in a middle state between too great a load of cares in the world, and the depression of poverty, we may with Agar be content: And whilst we strive to excel each other in arts and sciences, let not others out-strip us in content and a good life; it shall then be satisfaction enough for me, if I'm in some measure serviceable to my country, in a study not unpleasing to myself.

Pro captu lectoris habent sua fata libelli.

Griff, Juxta Covent. decimo nono Augustij, 1721.

Intro-

Introduction and Corrections.

It was a rule laid down by my predecessor, that whoever sent questions, enigmas, &c. should give the solutions with them, and this experience shews me is very requisite: for it may sometimes so happen, that an enigma may be doubtful, or admit of more solutions than one, which utterly destroys the design. And as it seems very difficult in mathematical questions, where terms of art are to be preserv'd, to write clear, intelligible, and in a smooth stile, confining one's self to the jingle of words; it may not be wonder'd at, that some questions have not been so clearly express'd as to meet with a true solution, such as their authors design'd. It is on this account I have here corrected some faults in the answers last year, which are fully demonstrated by Mr. *J. Jope*, jun.

Quest. 75, in diary 1720. Put n for the time after Michaelmas 1719. Then $100 : 5 :: 320 : 16$ and $1 : 16 :: n : 16n$, the interest of $320\text{ }l.$ Then $320 + 16n =$ the amount of $320\text{ }l.$ $5 - n =$ the time the $202\text{ }l.$ was received before due. $1 : 5 :: 5 - n : 25 - 5n$ and $125 - 5n : 100 :: 202 : \frac{20200}{125 - 5n}$ = value $202\text{ }l.$ at the day of payment. Then by the question $16n + \frac{20200}{125 - 5n} = 202$, which by reduction gives $n = 1.760076 = 1$ year 277 days 10 hours. So that the day of payment should be July 4th, 1721.

Paradoxes answered.

Par. 1 answer'd. In any deep well or coal-pit, from the bottom, if the shaft be streight, and there happen to be stars of any considerable magnitude in or near the zenith, you'll by a minute or two steadfast looking up discover them. Some astronomers have wells for that purpose.

Par. 2 answer'd. In several places where the water for some space runs under ground; as the river Guadiana in Spain. But our own country of Warwick has such a bridge.

The river Ichene, from a Saxon word, to search or penetrate, is denominated the parish of Long Ichington. On a common near Over Ichington is a pool whose stream entereth the ground, and after an intricate passage of half a mile, cometh ont again and passeth along the brook. And Ichelham near Windsor has its appellation from such a passage.

Par. 3 answer'd. The prime meridian, from whence longitude is accounted both ways, passes through the middle betwixt the ship and island, and so regard is had to the east and west longitude, and not to the points of the compass.

Par. 4 answer'd. The person was born in leap year, Feb. 29.

Questions answer'd.

* I. *The 84th question answer'd by Mr. Cha. Glover.*

Let a = the greater side, e = lesser. There's given the difference of the sides d , and the sum of their squares z ; which by involution, subtraction, and evolution, this equation is found,

$$a = \frac{d + \sqrt{2z - dd}}{2}; \text{ so } a = 38, e = 26 \text{ the solution.}$$

† II. *Question 85 answer'd.*

The cloud's height is 1747 yards by the prop. By some tables and rules it is 1744⁸; but taking no notice of the ☉'s alt. at the different places, 'tis 1746³.

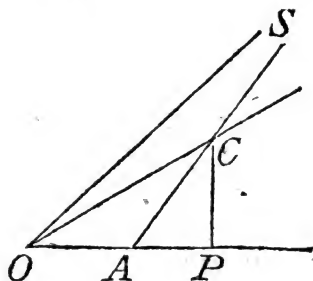
III. *Question*

* I. QUESTION 84.

Put z = the half sum of the two numbers, d = 6 the half difference, and s = 2120 the sum of their squares. Then $z + d$ and $z - d$ = the two numbers; the sum of whose squares is $2zz + 2dd = s$. Hence $z = \sqrt{\frac{1}{2}s - dd} = \sqrt{1060 - 36} = 32$; and therefore 38 and 26 the two numbers.

† II. QUESTION 85.

Let S be the sun, C the cloud, and O the observer, all in the same vertical plane; upon the horizon OP let fall the perpendicular CP the height of the cloud; draw SC , and produce it to cut the horizon in A the shadow of the cloud. Then OA will be given = 2304 yards, the angle $AOC = 20^\circ$; and if the elevation CAP of the sun at A be



* III. *Question 86 answer'd by Mr. John Jope, jun. of Loo, in Cornwall.*

$x^4 + 2ax^3 + a^2 + 2b^2x^2 + 2ab^2x = \frac{a^2b^2R^2}{c^2} - a^2b^2 - b^4$. Where x is found $= 15.103$: whence the course is S. $15^\circ 21'$ W. and the distance $= 57.035$ leagues. The other course is S. $53^\circ 21'$ W. and the distance 92.139 leagues.

A full and compleat algebraic solution, by Mr. Andrew, room will not admit.

IV. *Question*

be supposed $=$ the elevation SOP at O , then the angle $CAP = 35^\circ$, the $\angle OAC = 145^\circ$, and $\angle OCA = 15^\circ$.—Hence, As s. $\angle ACO : OA ::$ s. $\angle AOC : AC = \frac{s. 20^\circ}{s. 15^\circ} \times AO$; and, in the triangle APC , as 1 (rad.) : s. $\angle CAP :: AC : CP = \frac{s. 20^\circ \times s. 35^\circ}{s. 15^\circ} \times AO = 1746.34$ yards, or near a mile for the height of the cloud.

But as 2304 are rather above 1 minute of a degree of a great circle, the $\angle CAP$ will be about $35^\circ 1'$, and then $CP = \frac{s. 20^\circ \times s. 35^\circ 1'}{s. 15^\circ 1'} \times AO = 1745.17$ yards the distance, a little less than before.

* III. QUESTION 86.

The meaning of this question is, that three ships sail from a port to three other ports in the same parallel of latitude; the one of them sails direct south a given distance, the other two between the south and west, the differences of their courses being given, and the distance between their two ports. Or, in other words, Given the base, the perpendicular, and the vertical angle of a triangle, to find the rest.

Let C, P, A, O (see the last fig.) be the four ports; then $CP = 55$ leagues, $AO = 57$ leagues, and $\angle ACO = 38^\circ$. Now, by prop. 13 Simpson's Trigon. As 1 : cot. $\frac{1}{2} \angle ACO :: 2AO \times CP : \overline{OC + CA}^2 - AO^2$; hence $OC + CA = \sqrt{AO^2 + 2AO \times CP \times \cot. \frac{1}{2} \angle ACO} = \sqrt{57^2 + 57 \times 110 \times \cot. 19^\circ} = 146.487$ the sum of the sides. And, by prop. 14 of the same, 1 : tan. $\frac{1}{2} \angle ACO :: 2AO \times CP : AO^2 - \overline{OC - CA}^2$; and hence $OC - CA = \sqrt{AO^2 - 2AO \times CP \times \tan. \frac{1}{2} \angle ACO} = \sqrt{57^2 - 57 \times 110 \times \tan. 19^\circ} = 33.016$ the difference of the sides. Then, the half sum increased and diminished by the half difference,

we

* IV. Question 87 answer'd.

	hours	☉'s alt.	azim.	leng. shade	
The 10th March.	VIII	17° 36'	65° 32'	318'2	} Feet.
Latitude 52.	IX	25 48	51 45	212'9	
	X	32 13	36 14	163'4	
	XI	36 29	18 47	139'23	
	XII	38 0	0 0	131'83	
	I	36 29	18 47	139'23	

The figure will be triangular, the shadow at 8 and 1, being two of its sides, and right lines; the third (the path of the nodus or top of the tree) a curve line, of the conic sections, about 334 foot. The content 22200 square feet = 2 ro. 1 per. and 148 square feet. Those who have taken the horizontal distances with respect to the pole, instead of the azimuths, have given false solutions.

This

we have 89° 75' 15 and 56° 73' 55 for the two distances CO and CA . Again, as 146° 48' (sum of sides) : 33° 01' 6 (diff. sides) :: cot. 19° ($\frac{1}{2} \angle OCA$) : tan. 33° 12' = half the difference between the angles A and O ; and from the half sum and difference those angles are found = 104° 12' and 37° 48' the complements of 14° 12' and 52° 12' the two courses required.

It is evident that this problem will be constructed, by describing on the given base AO a segment of a circle to contain the given vertical angle; and then a line drawn parallel to the base at the distance of the perpendicular from it, will cut the circle in the vertex of the triangle.

* IV. QUESTION 87.

The piece of land in this question is a triangle on the horizontal plane, of which two sides are the shadows of the tree at 8 and 1 o'clock, and the third side the line described by the shadow of the top of the tree between the same two hours; and this third line will be right as well as the two former, and not a conic section, because the sun is in the equinoctial, it being the 10th of March old stile. The said third line will also be directly east-and-west, or perpendicular to the meridian or shadow of the tree at 12 o'clock.

Now

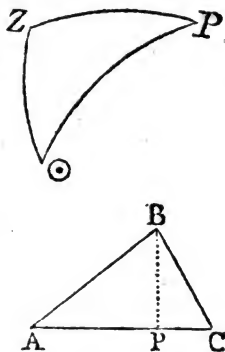
This question may be wrought thus :

As rad. — — 90° 0'	As cotang. lat. 52° 0' 9.89280
To cosine lat. 52 °	To radius — — — 10.00000
So is cosine of } 60 °	So tang. altit. 17 56 9.51005
the hour } 17 56	To line azimuth 65 32 9.61724
To sine of the altitude }	

As line $17^{\circ} 56'$: log. 103 :: line $72^{\circ} 4'$: log. 318, and so for the rest. And you'll have several triangles with 2 sides and an angle between them given, to find their contents; which in one sum gives the area of the whole more exact than by taking it as one single triangle, by reason of the curve line in each of them.

V. The

Now, if P represent the pole, Z the zenith, and \odot the sun at any hour: Then are given PZ the co-latitude, $P\odot$ a quadrant, and $\angle P$ = the hour from 12; to find the $\angle PZ\odot$, the sun's azimuth or bearing at that hour. And, taking the extreme hours 8 and 1 in the question, their azimuths will come out $65^{\circ} 32'$, and $18^{\circ} 47'$; which are the two angles ABP , CBP , contained by the meridian shadow BP , and the two extreme shadows BA , BC , the place of the tree being at B . Now, the sum of these two angles is $84^{\circ} 19'$ = the $\angle ABC$, and their complements are $24^{\circ} 28'$ and $71^{\circ} 13'$ = the angles A and C . So that all the angles are then known.



Again, the meridian altitude of the sun being 38° = the complement of the latitude 52° , we shall have as 1 : tang. 52° :: 103 feet (the height of the tree) : 131.834 = BP the length of the meridian shadow. From hence, and the given angles, AP and PC are easily found = 289.73 and 44.837, and then the area = 22053.65 square feet = 2.0218 roods.

* V. *The 88th Question answer'd by Mr. L. Evan.*

If 3'633959 be the area of a heptagon, whose side is 1; then put x = the acres, $11x$ = shillings, the price of 1 acre. $1 : 11x :: x : 11xx$ = the price in shillings of all the acres bought = inches round the polygon; 6272640 inches = 1 acre.

$$3'633959 : 1 :: 6272640x : \frac{6272640x}{3'633959} = \text{square each side.}$$

7 times the square root of that = $11xx$. That is $\sqrt{\frac{6272640x}{3'633959}}$
 $= \frac{11xx}{7}$, or $\frac{6272640x}{3'633959} = \frac{121x^4}{49}$, or $\frac{307359360x}{3'633959} = 121x^4$;
 hence $307359360x = 439'709039x^4$, and $699006'235 = xxx$.
 Then $88'74999 = 88$ ac. 2 ro. 39 per. = x the number of acres bought. 976'24989 shill. = 48*l.* 16*s.* = the price of 1 acre.

VI. The 89th, or *Adraſtea's* question, by the omiſſion of a line or two to limit it, admits of many answers.

For when the number of quantities ſought exceeds the number of given equations, the queſtion is capable of innu-merable answers.†

24

* V. QUESTION 88.

Since the price of one acre in ſhillings is equal to 11 times the number of acres, it is plain that the price of all the acres will be 11 times the ſquare of the number of acres; but the price of the whole is equal to the circumference in inches, therefore the circumference in inches is equal to 11 times the ſquare of the acres.

Now if x denote the ſide of the heptagon in inches, $a = 3'633912$ the area of a heptagon whoſe ſide is 1, and $b = 6272640$ the inches in an acre. Then $7x$ will be the perimeter, and $\frac{ax^2}{b}$ the acres;

$$\text{wherefore } 7x = \frac{11a^2x^4}{b^2}; \text{ hence } x = \sqrt[3]{\frac{7bb}{11aa}} = 12377'1 =$$

the ſide. Then $\frac{ax^2}{b} = 88'7487$ the number of acres.

† VI. QUESTION 89.

In the above original answer, it is juſtly remarked that the *data* are inſufficient; for, to have limited the answers, there ought to have been three more conditions; ſo if three of the numbers of perſons had been given, the queſtion would have been confined to one answer, and the method of ſolution too eaſy to need any pointing out here.

$$24 \left\{ \begin{array}{lcl} 2 \text{ captains} & 4l. \text{ each} & = 8l. \\ 4 \text{ mates} & 2 & = 8 \\ 14 \text{ sailors} & 10s. & = 7 \\ 4 \text{ boys} & 5 & = 1 \end{array} \right\} \begin{array}{l} l. \\ \\ \\ 24 \end{array}$$

Mr. Evan has collected 100 true answers, which for brevity I omit.

* VII. *The 90th Question answer'd by Mr. Cha. Glover.*

Let a = eldest son's portion, e = youngest, $aa = se$, and $s - a = e$ per quest. this equation is produced,

$$a = \sqrt{ss + \frac{1}{4}ss} - \frac{1}{2}s. \quad a = 30901.69943746 \text{ or } 30901l. 14s. \\ e = 19098.30056251 \text{ or } 19098l. 6s.$$

† VIII. *The 91st Question answer'd by Mr. J. Andrew.*

The transverse diameter 16'184253 perches = 89'01 yards.

The conjugate diameter 12'587597 perches = 69'23 yards.
Distance between the focus points 55'9463; thence to the extreme parts 44'505, doubled 89'01 added to the distance between the foci is the length of the tether 145 yards.

The

* VII. QUESTION 90.

In this question are to be found two numbers, of which the sum is given, and the square of the greater equal to the less multiplied by the given sum. Or, it is required to divide a given number into two such parts, that those parts and the whole may be three numbers in geometrical progression. Or, in other words again, to divide a given number according to extreme and mean proportion; which it is well known will not admit of an answer in integer numbers.

Put $s = 50000$ the sum, and x the greater part. Then $s - x =$ the less, and $xx = ss - sx$; hence $x = \frac{\sqrt{s^2 - 1}}{2} \times s = 30901.6994375$, and consequently the other part = 19098.3005625, as above determined.

† VIII. QUESTION 91.

Put $9x$ and $7x$ for the two axes in yards. Then $63xx \times 785398 \&c. = 4840$ the square yards in an acre. Hence $x = \sqrt{\frac{4840}{63 \times 7854}} = 9.890255$; consequently $9x$ and $7x$ become 89'0123 and 69'2318 for the two axes. Then $89'0123 + \sqrt{89'0123^2 - 69'2318^2} = 144'96 =$ length of the tether.

The way for the horse to graze just an elliptical acre, is thus: Set up two stakes or pins in the longest diameter of the oval, 16 yards 6 inches and a quarter from the outside. Put a string of 145 yards long round both stakes, and tie the two ends together; at which knot let the horse's mouth be fix'd: then in going about he will exactly sweep the oval, containing 4840 square yards, or one acre.

* *The Prize Question answer'd.*

In answering this question in hydrostatics, the philosophy of the gravity and pressure of fluids is to be consider'd: That at the first moment the cock or adjutage is open'd, the liquid flows out with the same velocity as a heavy body moves when fell from that height the liquor came, or the place of the reservoir. The water that enters the top or mouth of the pipe, moves as fast as that flowing out, at what depth

* PRIZE QUESTION.

Put a = the altitude of the surface of the water above the delivering pipe, n = the area of the orifice or pipe, and $m = 32\frac{1}{2}$ feet = 386 inches. Then proceeding as in page 4 of our new Math. Miscel. $\sqrt{2ma}$ will be the velocity of the issuing water, upon the supposition of the question, that it is equal to that of a heavy body after falling through the space a ; but if, according to Sir I. Newton and some others, the velocity be that which is acquired by falling through only $\frac{1}{2}a$, it will be \sqrt{ma} ; which is to the former as 1 to $\sqrt{2}$, and therefore the time for the one supposition may be found from that of the other, by this proportion of 1 to $\sqrt{2}$.

Now in the former case with the velocity $\sqrt{2ma}$ per second, we shall have $n\sqrt{2ma}$ for the quantity run out per second; and therefore $n\sqrt{2ma} : \mathcal{Q} :: 1 \text{ second} : \frac{\mathcal{Q}}{n\sqrt{2ma}} =$ the seconds in which the quantity \mathcal{Q} will be voided.

Then, for the king, $\mathcal{Q} = 12\frac{1}{2}$ hogsheads = $12\frac{1}{2} \times 63 \times 231$ or 176715 cubic inches, $n = 1.75^2 \times .7854$, and $a = 10\frac{1}{2}$ feet = 126 inches; with which numbers $\frac{\mathcal{Q}}{n\sqrt{2ma}}$ becomes 235.565 seconds, or 3 min. 55 $\frac{1}{2}$ sec.

And, for the people, $\mathcal{Q} = 20$ hogsheads = 291060 inches, $n = 2^2 \times .7854 = 3.1416$, and $a = 22$ feet = 264 inches; which numbers give 205.22 seconds = 3 min. 25 $\frac{1}{2}$ seconds; both nearly as in the original answer.

But if the other supposition be used, of \sqrt{ma} velocity per second; then each of the above times must be multiplied by $\sqrt{2}$.

depth foever, in an equal cylinder. Whereas a heavy body moves slow at first setting out, and continually receives a new impulse of gravity, which when it has fallen the length of the water-pipe, is equal in velocity to that column of water. Then as a body accelerates with the odd numbers 1, 3, 5, &c. the water going out as fast the first space, as a weight falls in the second; consequently must be as Gravesand, in his Mathematical Philosophy, page 188, N^o 378, says,

“ In the time in which a body falling freely, goes through the height of the liquid above the hole, a column of the liquid flows out equal in length to twice that height.”

On this principle was the question composed, having Gravesand then before me; which is plain from the question itself, the word [acquired] meaning no other, than that the water moved as fast as the body, when it had fallen the height of that liquid: But the design of putting it in those words was to prevent such who had not skill enough in philosophy, stamping a solution to it.

The king used 765 gall. = $12\frac{1}{2}$ hogsheads per day. The bore 1.75 inch squared \times by 252 double height \div 294.12 gives 2.6579 w. g.) 765 (287.9 times (the height) for the quantity. \square 6c^m = 3600) 192 (.05333 inch, the space accelerated in 1 third. Then $10\frac{1}{2}$ feet = 126 inches — .05333 gives 48.621 thirds multiplied by 287.9 is 13994.819 thirds = 3' 53" 14^m. *The answer.*

The people use 1260 gallons per day.

Height dupla 528 \times 4 dia. sq. \div 294.12 = 7.18 w. g.

1260 \div 7.18 = 175.49 such columns $\sqrt{\frac{22}{16}} = 1.17 \times$
 $175.49 = 205.3233 = 3' 25" 32^m. *The answer.*$

Of the Eclipses in 1722.

In the annual revolution of that glorious body the sun, three times will the dark body of the moon interpose and eclipse its light from us; and twice will the earth interpose between the sun and moon, and deprive her of a borrow'd light.

1. Sun eclipsed, Saturday the 6th of January, 6 min. after 11 o'clock in the morning, but not visible to us in England: the moon's latitude causing the shadow to fall in the more southern countries.

2. Sun eclipsed, Saturday the 2d of June, 40 min. after 7 in the evening, but invisible.

3. Moon eclipsed, total and visible, on Monday the 18th of June, at 2 in the morning.*

	Beginn.	Middle	End	Digits
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Adraſtea's calcul. Coventry	0 3 41	1 40 20	3 17 0	13 39 40
Coventry by Chattock	0 3 43	1 40 27	3 17 11	13 42 5
Aſtronomia Britan. London	0 13 51	1 54 31	3 35 11	14 13 49
London by Silvia	0 13 32		3 27 20	13 15 0
Lond. Flamſt. Table Gibbon	0 13 16	1 51 33	3 29 50	13 56 2
London by Leadbetter	0 19 50	1 56 37	3 33 24	13 32 0

4. Sun

* This eclipse of the 18th of June was observed

1. At *Greenwich* by Dr. Halley thus.

App. Time.

h. m.

13 12

13 29

15 26

15 27

} Between these two times the eclipse became total.

} Between these times the end.

2. At *Port Royal* in *Jamaica* by Capt. Candler.

h. m. s.

6 59 10

8 7 50

9 11 0

10 19 40

8 39 25

The eclipse began.

Immersion.

Emerſion.

The end.

Whence the middle.

So that the diff. of long. between *Port Royal* and *Greenwich* will be 5 h. 6 m. 50 s. or 5 h. 6½ m. from *London*; that is, 76° 37½'.

3. At *Berlin* by Mr. Chriſtified Kirck.

h. m. s.

12 59 55

14 8 8

Beginning.

Immersion.

Berlin is 54 m. of time, or 13° 30' of long. east of *London*.

4. Sun eclipsed, visible, Tuesday the 27th of November, 50 minutes past 2 in the afternoon.*

	Begins	Middle	End	Digits
	h. m. s.	h. m. s.	h. m. s.	d. m. s.
By Astronomia Carolina	I 43 31	II 47 53	III 48 20	5 15 31
at Coventry	I 31 42	2 41 23	3 47 10	6 3 56
Scientia Stell. Coventry	I 50 52	2 58 17	4 1 20	5 47 0
Leadbetter, London				

5. Moon eclipsed, visible, Tuesday the 11th of December, 21 minutes past 3 in the afternoon.

	h.	m.
The beginning at	II	7
Greatest obscuration	III	21
The end — —	III	34
Whole duration —	2	27
Digits eclipsed —	5	29

Novo

* This eclipse of the 27th of November was observed thus.

1. At *Greenwich* by *Dr. Halley*.

Tempora.

h.	m.	s.	
1	29	16	Eclipsin jam inceptam vidi.
3	43	25	Finis eclipses dubius, ob limbum solis asperum & undulantem nec sat bene definitum.
3	43	45	Certe desierat eclipsis.

2. At *London* by *Mr. G. Graham*.

App. Time.

h.	m.	s.	
1	28	38	Beginning.
3	43	22	End
2	14	44	Duration.
5	7	16	dig. Quantity eclipsed.

3. At *Wakefield* in *Yorkshire* by *Mr. Hawkins*.

h.	m.	s.	
1	21	0	Beginning.
3	30	3	End.

The sun's diameter obscured somewhat more than 5 digits.

4. At *Cambridge* in *New England* by *Mr. T. Robie*.

h.	m.	s.	
9	25	45	The end of the eclipse.

Mr. Owen Harris, an ingenious Schoolmaster in *Boston*, says he observed the end at about 9 h. 26 m.

New Paradoxes.

Par. 1. There are divers remarkable places upon the terraqueous globe, whose sensible horizon is commonly fair and serene; and yet 'tis impossible to distinguish properly in it any one of the intermediate points of the compass; nay, not so much as two of the four cardinals themselves.

Par. 2. There are three distinct places of the earth, all differing both in longitude and latitude, and distant from one another two thousand miles compleatly; and yet do all bear upon one and the same point of the compass.

Par. 3. There are three distinct places on the continent of Europe, lying under the same meridian; and at such a distance, that the latitude of the third surpasseth that of the second, by so many degrees and minutes exactly, as the second surpasseth the first; and yet the true distance of the first and third from the second (or intermediate place) is not the same by a great many miles.

New Questions.

I. Question 92, by Mr. J. Andrew.

How much to mathematic art is due,
None truly know but those that it pursue:
The lofty paths trac'd by great Newton's hand,
Or those whose works like his will ever stand,
Long as Ægyptian piles, but yet more bright,
And to succeeding ages give a pleasing sight.
Gen'rous Halley, ne'er equall'd yet we knew;
Great Britain's sons will long his numbers view;
Their wond'rous works with admiration tell,
What pains they took, and how they did excel.

You ladies, who in numbers' sports are known,
Let's know the greatest frustum of a cone,
(In ale gallons) in a semi-spheroid,
Transverse thirty, and twenty inches wide.

II. Question 93, by Mr. C. Mason.

Seen, June the ninth, a lofty tower to be,
In height two hundred fifty foot and three.
Upon its top a veering fane, but I
At that same time could not its height descry:

The

The sun then shone, I did the shadow take
 The tower and fane did both together make;
 Whose length I found the height o'th' tower to be;
 Its bearing north north-west appear'd to me.
 In latitude, degrees just fifty-four;
 The height describe; the fane's above the tower.

III. *Question 94, by Mr. Richard Whitehead.*

I by an ancient writing understand,
 My grandfather inclos'd a piece of land
 With three brick walls, and then a garden made;
 Green were the walks, and cooling was the shade:
 A circling hedge of yew in which he plac'd,
 And artful knots of flowers the circle grac'd,
 Each wall was touch'd, by whose periphery
 In the south wall you might a door-place see,
 Just at its point of contact: Thus 'was cut
 Into two segments, as in margin put. $39\frac{1}{2}, 30\frac{1}{2} \text{ yards.}$
 From corner opposite to that same wall,
 A perpendicular's suppos'd to fall;
 Its segment's product then in yards will be, $1181\frac{1}{2}\frac{7}{8}\frac{1}{2}.$
 I pray, ye ladies fair, declare to me
 The garden's true content, length of each wall,
 Circle's diameter, as they do fall?

IV. *Question 95, by Mr. Alex. Naughley.*

As I happen'd once with a gauger to drink,
 Who, proud of his art, would venture his chink,
 That by right *data* he'd find to a gill,
 Any tun's content in malt, wine, or ale.
 Good luck it was then, a maltster was there,
 Put on by the host, laid a wager of beer.
 The dimensions given here you may see,
 Of his own by-tub, he could not tell me,
 What bushels it held, to a nicety.
 The lesser diam. was inches thirty-two,
 Segments, by cutting the diagonals, two,
 Were twenty and thirty, appeared to view.
 Then the gauger, incensed, wrought with his pen,
 Cane, tape, rule, and tables; but all was in vain:
 So, ladies, your aid he begs for this bout,
 That the tale of a tub turn him not out.

V. *Question 95, by Mr. Joseph Smith.*

Near to the borders of the German main,
 There lies a piece of land, an even plane,
 In form triangular, but not right:
 The fences of the land lie very straight;
 The sum of the sides make twice forty-eight.
 The third part of the longest fence, I know,
 Is just the difference of the other two;
 And two chains lesser than the shortest fence,
 Makes true the base's segment's difference.
 Three men they bought this land the other day,
 And I must part it for them, as they say,
 By art, and in a new unheard-of way.

In this same ground, a certain point there lies,
 That if the field was hung, would poize
 It equally above our earthly ball,
 That neither side would rise, nor neither fall:
 To this same point, their fences I must bring
 From the three angles, by a chain or string;
 The length o'th' fences of each sev'ral part,
 I do require, of all you sons of art.

VI. *Question 97, by Mr. R. Tapper.*

An only son I am; my age I fain would know;
 But the registers my age they cannot show:
 Yet all this I do remember very well,
 Which makes me think my age you'll quickly tell.

If to double my age, you place the square root,
 Of my age doubled, with five years more to boot;
 Square the last sum, and add it to the other,
 The aggregate of all those sums make together

Twenty-two hundred and sixty, less by four:
 My age to me, quickly pray declare. { 16 Jan.
 And canon true, to find it out this year. { 1724.

VII. *Question 98, by Mr. T. Raspberry.*

Three sisters jointly do agree
 To venture portions in south sea;
 But fickle fortune prov'd so cross,
 That each of them sustain'd a loss:
 The difference of their losses be,
 A, two thousand more than B,
 And nine thousand more than C.
 But one thing more I will declare,
 Of the eldest sister's loss, the square
 Is equal t'th' squares o'th' other two.
 Each lady's loss pray tell me true.

The

The Prize Question, by Adras tea; the answerer may by lot win 10 of these diaries.

Aspire my genius ! help my rhiming muse,
In themes I in my native country chuse :
Whilst others plow the waves and tread the strands
Of distant oceans, and of foreign lands ;
To fill the mouth of fame with somewhat new,
(No matter 'tis how much of it be true).
From alps or mountains, stories strange they bring,
Of desert caves, or horrid monsters sing.
Tell how Vesuvius' sulph'rous darts do fly,
Or Ætna's smoke obscure the azure sky ;
Or magnify the hazards they have run,
Scylla's and Charybdis's pointed rocks to shun.

Such tales we take in trust from those who rove,
Tho' none give rules by which the truth to prove.

But this by numbers may explained be,
By those who never did the cavern see :
In Derbyshire, a wonder of the Peake
Is Eldon-hole, as poets often speak ;
Whose depth exactly, none cou'd e'er descry,
Tho' atheist Hobbs his utmost skill did try,
Who wrote *De Mirabilibus Pecci*.

And burlesque Cotton does strange tales rehearse,
In rustic words, and hudibrastic verse,
How he this monstrous orifice did plumb,
But cou'd not at the bottom of it come,
With sixteen hundred yards of rope let loose ;
And tells a story of a woman's goose :
Fabulous the one, so may the other be,
Erroneous too, without philosophy ;
Extension of the rope might him deceive,
And small proportion which the plumb wou'd have
To such a length ; and part in water drown'd,
When in this vast abyss within the ground.

But I the depth have found, exactly true,
By gravity ; a method something new.
As heavy bodies do accelerate,
In spaces known first to our Newton great.
Four pond'rous stones into the well let fall
In measur'd time, agreed in numbers all ;
A pendulum, sixty-one inches long,
By which the time I measur'd (was not wrong)
Vibrated freely, whilst that each stone fell
Eight times ; by which the depth I'd have you tell.
Allowing rightly for th' approach of sound,
That your own works may not themselves confound.

A farther Dissertation on the Engine, continued from the last Diary.

The last diary gave you the calculation of an engine wrought by the pressure of the atmosphere; what materials were capable of raising any quantity of water, not exceeding 300 hogsheads an hour, at any depth under 100 yards. The general use it has deservedly obtained in mines, makes it needless to say any thing more of its service: A philosophical and mechanical description of the machine, is too large for my room here; I shall at present only observe, that the boiling water in a close vessel, has an expansion and elasticity in steam, almost incredible. One cubic inch of water will produce or fill 13300 cubic inches with steam, each with an elasticity to raise a pound avoirdupois, in the common way of working such engines. But each inch may be made to raise 10 or 20 atmospheres, viz. 756 tun: A thing not hitherto taken notice of.

I have been led, through curiosity, many years to observe most engines of any account for service; and to peruse all books of engines I could in any language; but 'tis very strange, to find none of them shou'd write in such a practicable method, as might inform or teach others, nor understand mechanics and numbers.

Enough either to guide them towards truth, or screen them from gross errors, when they give us a neat cut of an engine, turn'd by a current of water, or by wind or horses; and then tell us a romantic story, how the same may be wrought by a man or two men. One would think they never knew that the service of one horse equal'd the strength of five or six men; or that an overshoot wheel will exceed the strength of five or six and twenty horses, when suitably apply'd. They generally perplex the motions, one number giving power or velocity, and the next destroying it; making the friction great, and the working parts ill and unserviceable.

Engines are only valuable, as they carry a mathematical demonstration of their power and certainty. And could engineers consider that maxim, *What's gained in force, is lost in time; and what's got in time, is lost in force*; and Sir Isaac Newton's three laws of motion or nature; men would never entertain such ridiculous whims as perpetual motions, or pretend to do more than is possible, unless the Creator alter the whole fabric of nature.

Paradoxes

1723.

Paradoxes answered.

1 *Par. ansfw.* UNDER either of the poles.

2 *Par. ansfw.* All places differ in both longitude and latitude, at what distance soever, with respect to either poles bear upon the same point of the compass. Or they may be in the same spiral rumb; else understood as in the earth, and not upon it.

3 *Par. ansfw.* The oblate spheroidal figure of the earth will cause such a difference.

Questions answer'd.

* I. Mr. C. Maſon's answer to the 92d question.

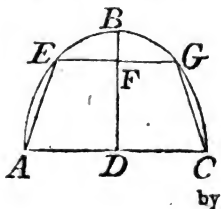
Accept, fair nymphs, this free-will offering,
Which I with rev'rance to your altar bring;
Tho' my poor mite ye need not, nor my praise,
For your own works will lasting trophies raise;
But gratefully acknowledge that I owe
The art to you, which these solutions show.

Let

* I. QUESTION 92.

To find the greatest frustum $AEGC$ of a cone that can be inscribed in a given semi-spheroid ABC , the base of the cone being the same as that of the spheroid, whether it be oblate or oblong, that is whether the revolving axe AC be the less or the greater axe of the ellipse.

Put $r = AD$ the semi-revolving axe, $f = DB$ the semi-fixed axe, and $x = DF$ the altitude of the frustum. Then,



Let the semi-transverse $15 = b$, and semi-conjugate $10 = c$, length of the frustum $= a$, the difference put $= b - a$, and the semi-head diameter $= e$. Then,

$bb : cc :: bb - aa : \frac{bhcc - ccaa}{bb} = ee$. Which reduced gives $a = 10.606601$, and $e = 7.075$, and $2e =$ less diameter $= 14.15$ inches; hence the content in ale gallons 8.6915 .

Mr.

by the ellipse, $ff : rr :: ff - xx : EF^2 = \frac{ff - xx}{ff} \times rr$; hence the solidity of the frustum will be

$rr + rr \sqrt{\frac{ff - xx}{ff}} + rr \times \frac{ff - xx}{ff} \times \frac{3.1416}{3}$, and there-

fore $x \times 1 + \sqrt{\frac{ff - xx}{ff}} + \frac{ff - xx}{ff} =$ a maximum.—Or,

put $zz = \frac{ff - xx}{ff}$, then $xx = ff \times 1 - zz$, and the maximum $= \sqrt{1 - zz} \times 1 + z + zz$; which put into fluxions and reduced, we have the equation $1 + z - 2z^2 - 3z^3 = 0$; whose root z is $= .6464881$ very exact. Hence $z = \sqrt{1 - zz} \times f = .762924f$, and the content of the greatest frustum $= .762924frr \times \frac{3.1416}{3} \times 1 + z + zz = 1.649344frr$.

Now in the case of the oblong spheroid, $f = 15$, $r = 10$, x the height $= .762924f = 11.44386$, and the content $1.649344frr = 2474.016$ inches $= 8.773$ ale gallons.

But if the spheroid were oblate, then $f = 10$, $r = 15$, $x = .762924$, and the content $= 3711.024$ inches $= 13.1597$ gallons.

Corollary.

From this solution it appears, that the value of x , or the height of the frustum, will be always the same, whatever the revolving axis AC may be; the said height being to the semi-fixed-axis, or DF to DB , as $.762924$ to 1 .—And the content $1.649344frr$ of the frustum $AEGC$ is to the semi-spheroid ABC or $2frr \times \frac{3.1416}{3}$, as 2.474016 to 3.14159 &c. or as $.787504$ to 1 .—Also, the frustum in the oblate is to the frustum in the oblong semi-spheroid, as the longer axis to the shorter, which is the same proportions as the spheroids themselves are in by Cor. 8 page 277 of Mensuration.

Mr. *Ri. Tapper*, by the doctrine of fluxions, gives this equation, $x^5 + \frac{1}{2}x^4 + \frac{4}{3}x^3 - \frac{2}{3}x = \frac{1}{3}$. Here the flowing quantity $x = .64638$. Hence this general theorem,

As 1 : the conjugate diameter of a spheroid :: .64638 : the lesser diameter of the largest conic frustum that can be inscribed. Whence

The lesser diameter — — 12.9277 } inches.
 Height of the conic frustum 11.4455 }
 The solid content — — 8.7734 ale gallons.

But Mr. *Andrew*, the proposer, gives this general theorem, $x^6 - 425x^4 + 67500x^2 = 3796875$: and the lesser diameter = 12.9297, and the content = 15.4587 ale gallons.

* II. *The 93d Question answer'd by Sylvia.*

If the bearing of the shadow be N. N. W. the sun must be upon the S. S. E. point, his azimuth then being $22^\circ 30'$ from the fourth, and his declination being the 9th June $23^\circ 30'$. In the latitude of 54° his altitude is $58^\circ 2'$.

As the tangent of $45^\circ 0'$ — — — 10.0000000

To the tangent of $58^\circ 2'$ — — — 10.2047732

So is the logar. 253 foot — — — 2.4031204

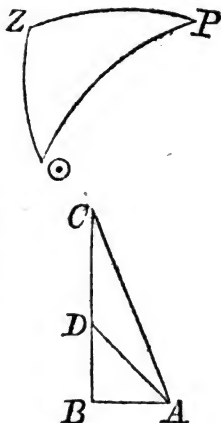
To the logar. 403.4 — — — 2.6078937

The height of the tower and vane together, but the vane's above the tower just 152.4 foot.

III. *The*

* II. QUESTION 93.

In the spherical triangle $ZP\odot$, given PZ the co-latitude = 36° , $P\odot$ the co-declination = $66^\circ 30'$, and the angle Z = the azimuth from the north = $157^\circ 30'$; to find the side $Z\odot$ = $31^\circ 58'$ = the co-altitude. Hence the altitude itself is $58^\circ 2' = \angle BAC$ in the second figure, in which the shadow AB = the tower BD = 253; then, by plane trigonometry, as radius : tang. $\angle BAC$:: $AB : BC$ = the height of the tower and vane together; from which taking away the height of the tower BD , there remains DC = the height of the vane, as in the original solution.



* III. *The 94th Question answer'd by Mr. Ri. Tapper.*

Let a = the greater segment taken from the perpendicular, e = lesser segment, and s = their sum = 70, p their product $1181\frac{1}{9}\frac{7}{10}$ yards. There comes out this equation,

$$\left. \begin{aligned} a &= \frac{1}{2}s + \sqrt{\frac{1}{4}ss - p} = 41'6090925304966547 \\ e &= \frac{1}{2}s - \sqrt{\frac{1}{4}ss - p} = 28'3909074695033453 \end{aligned} \right\} \text{yards.}$$

Put x for the unknown tangent, b = the greater segment, d = the lesser, from whence this equation is brought out

$$x = \frac{dd + aa - bb - ee}{18} = 16'4040530149739870499445.$$

Hence the length of the walls are,

Longest 70,

Next - $55'904530149739870499445$,

Shortest $46'9045$ &c.

For the perpendicular's length, let a = the shortest side; then, by Eucl. I. 47, $\sqrt{gg - ee} = 37'40536$ yards.

Hence the area = $1309'1876$ square yards = 1 ro. 3 per. &c.

To find the angle subtended by the perpendicular, and made by the shortest side and shortest segment.

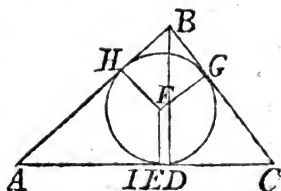
As the less segment : radius :: perpendicular : tang. $52^\circ 48'$.

As radius : tang. of $\frac{1}{2}$ last angle :: lesser segment $30'5$: $15'14$, half of the diameter; so the diameter is $30'28$.

IV. *The*

* III. QUESTION 94.

In this question we have given, in the triangle ABC , the base AC = 70, the rectangle of the segments of the base, made by a perpendicular, $AD \times DC$ = $1181\frac{1}{9}\frac{7}{10}$, and the segments of the base made at the point of contact of the inscribed circle, viz. $AE = 39\frac{1}{2}$, and $CE = 30\frac{1}{2}$; to determine the triangle.

*Algebraical Solution.*

Put $s = 35 = AI = IC$, $p = 1181\frac{1}{9}\frac{7}{10} = AD \times DC$, and $z = ID$ = half the difference between AD and DC . Then $AD = s + z$, and $DC = s - z$; hence their product $ss - zz = p$, and therefore $z = \sqrt{ss - p}$. Then $AD = AH = s + \sqrt{ss - p}$, and $DC = CG = s - \sqrt{ss - p}$. — Again, since

IV. *The 95th Question answer'd by Mrs. Eliz. Dod.*

If gaugers wou'd their business mind,
 And follow their excise;
 They their account therein would find,
 Without this stir and noise;
 Let 'em no more their boasted art
 Extol, since 'tis our aid
 That does the tub's content impart,
 Tho' they for that are paid.

The

since BH is $= BG$, we shall have the difference of the sides $AB - BC = AH - CG = AE - EC = 9$; then, by a known rule, $AE - EC : AD - DC :: AC : AB + BC$; the sum of the sides being then known, from it and their difference the sides themselves are easily found. Also $BD = \sqrt{BA^2 - AD^2}$, and $\frac{1}{2} BD \times AC =$ the area. — Lastly, the double area of the triangle being divided by its perimeter, the quotient will be the radius FE of the inscribed circle.

Geometrical Construction.

Let I be the middle of the given base AC , and E the point of contact with the circle. By Eucl. II. 14, make a square equal to the given rectangle of the segments of the base, which call S^2 ; then take ID equal one leg of a right-angled triangle of which S is the other leg and AI the hypotenuse; so shall AD , DC be the segments of the base made by the perpendicular. — For, by Eucl. II. 5, $AI^2 = AD \times DC + ID^2 = S^2 + ID^2$ by the construction; therefore AI , S , and ID form a right-angled triangle by Eucl. I. 48.

Again, take BG or BH a fourth proportional to $2IE$, ED , and AC ; which being added to $AH = AE$, and to $CG = CE$, the two sums will be the two sides AB , BC , of the triangle. — For, by Eucl. III. 37, $AE = AH$, $CE = CG$, and $BH = BG$; and it remains only to prove that BG or BH is the 4th proportional mentioned above. Now, by Simpson's Geom. Cor. 2. 9. II, as $AB - BC : 2ID :: AC : AB + BC$; but $AB - BC (= AH - CG = AE - EC) = 2IE$, and $AB + BC (= AH + HB + BG + GC) = AC + 2BG$; therefore the proportion becomes $2IE : 2ID :: AC : AC + 2BG$; hence, by division, $2IE : 2ED :: AC : 2BG$, or $2IE : ED :: AC : BG$. Q. E. D.

The calculation from hence is very easy and evident.

Diary Math.

X

The greatest diameter 48. Lesser 32. Depth 30 inches.
Content 17'764834 malt bushels.*

† V. *The 96th Question answer'd.*

The three sides of the triangle are 42, 34, and 20 chains.
The internal fences 24'586, 18'773, and 12'238. The content 33'6 acres.

Divide each side of the triangle into two equal parts, from whence draw lines to the angles opposite; the point in which these intersect is the center of gravity of the triangle; and and where it would be, if hung up, equally poised.

VI. *The*

• IV. QUESTION 95.

$ABCD$ being the tub, we have given $DC = 32$, $AE = EB = 30$, and $DE = EC = 20$.

Upon the middle of the base of the isosceles triangle DEC let fall the perpendicular from the angle E ; and from the top of the tub let fall the perpendicular BF . Then, in the right-angled triangle DEG ,

$$EG = \sqrt{DE^2 - DG^2} = \sqrt{20^2 - 16^2} = 12; \text{ and in}$$

the similar triangles DEG , DBF , as $DE = 20 : EG = 12 :: DB = 50 : BF = 30$. Also, by similar triangles, $ED : DC :: EA : AB = 48$. Hence the content = $.7854 \times BF \times$

$$\frac{AB^2 + AB \times DC + DC^2}{3} = 30 \times \frac{48^2 + 48 \times 32 + 32^2}{3}$$

$$\times .7854 = 12160 \times 3.14159 \text{ \&c.} = 38201.77 \text{ cubic inches} = 17.7648 \text{ malt bushels.}$$

† V. QUESTION 96.

Let AC be the base or longest side of the proposed triangle ABC , and BD the perpendicular. — Put $z = BC$ the shortest side, and y the other side AB . Then, by the

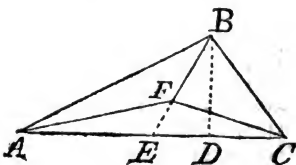
question, $z - 2 = AD - DC$, and the greatest side AC (or

$AD + DC$) $= 3y - z$, also the sum of all the three sides

$4y - 2z = 96$, or $2y - z$

$= 48$. But, by the nature of

the triangle, $AC : AB + BC$



$$:: AB$$

* VI. *The 97th Question answer'd by Mr. C. Mafon.*

It is evident this question is composed from that in page 225 of Ward's Mathematician's Guide.

Suppose $\frac{aa}{2}$ = to his age.

$aa + a + 5 = 47$. Involved is

$a^4 + 2a^3 + 12aa + 11a + 30 = 2256 = b$. Then by completing the square will be produced this canon,

$\sqrt{\sqrt{b + 0.25} - 5.25 - 0.5} = a$, and $\frac{aa}{2} = 18$ years old.

To

$\therefore AB - BC : AD - DC$, or $3.y - z \times z - 2 = y + z \times y - z$; hence $3.z - 2 = y + z$, or $2z - y = 6$. From this equation, and the one above, viz. $2y - z = 48$, we easily find $z = 20$, and $y = 34$. Consequently the third side $3.y - z$ is 42.

Now the point F upon which the triangle will be in equilibrium is the center of gravity; and lines drawn through the center of gravity, from the angular points, bisect the opposite sides; that is, BF produced bisects AC in E ; also the distance between the angular point and the center of gravity is two-thirds of the whole line, that is $BF = \frac{2}{3}BE$. But, by theor. II book 3 Simp. Geom. it is $2BE^2 + \frac{1}{2}AC^2 = AB^2 + BC^2$; hence $BF (= \frac{2}{3}BE)$

$$= \frac{2}{3} \sqrt{\frac{AB^2 + BC^2 - \frac{1}{2}AC^2}{2}} = 12.238373. \text{ In the same}$$

$$\text{manner } AF \text{ is } = \frac{2}{3} \sqrt{\frac{AB^2 + AC^2 - \frac{1}{2}BC^2}{2}} = 24.5854519,$$

$$\text{and } CF = \frac{2}{3} \sqrt{\frac{AC^2 + CB^2 - \frac{1}{2}AB^2}{2}} = 18.77350379.$$

* VI. QUESTION 97.

The method of completing the square in the above original solution is thus. — Since $a^4 + 2a^3 + 12a^2 + 11a + 30$ is $= aa + a + 5]^2 + aa + a + 5 = b$; by completing the square, we have $aa + a + 5 = \sqrt{b + 0.25} - 0.5$; and, by completing the square again, it is $a = \sqrt{\sqrt{b + 0.25} - 5.25 - 0.5} = 6$. And then $\frac{1}{2}aa = 18$.

To this Question Cælia Beighton thus answers.

I've view'd your query, Mr. Tapper, well,
 And found a rule by which your age to tell.
 " Extract th' square root o'th' number giv'n,
 " Quote or remainders forty-seven;
 " From whence take five, and there remains
 " Just forty-two, which with small pains
 " You may extract, the root is six,
 " And six remains; therefore I fix
 " The square of six your double age:
 " From hence you have a theorem true,
 " Which now I have explain'd to you.

* VII. *The 98th Question answer'd by Mr. Lewis Evan.*

Put a, e, u = their several losses, $b = 2000$, and $c = 9000$. Then

$$\left. \begin{array}{l} a = b + c \\ e = c \\ u = b \end{array} \right\} + \sqrt{2bc} = \left\{ \begin{array}{l} 17000 \text{ } A \\ 15000 \text{ } B \\ 8000 \text{ } C \end{array} \right\} \text{ lost.}$$

The

* VII. QUESTION 98.

The theorems, in the original solution above, for determining the values of the three quantities required, are found thus.

Denoting the two differences between the greatest and each of the other two by b and c , as above, and the least quantity itself by x ; then $x + c$ = the greatest, and $x + c - b$ = the middle one:

hence, by the question, $(x + c)^2 = x^2 + (x + c - b)^2$; from which equation we have $x = b + \sqrt{2bc}$.

Then $x + c - b = c + \sqrt{2bc}$,

and $x + c = b + c + \sqrt{2bc}$,

which are the three quantities required.

* *The Prize Question answer'd.*

August 18, 1718, Adraſtea let fall 3 ſeveral ſtones into Eldon-hole, which fell with little or no obſtruction, and accelerated in 9, 11, and 10 ſeconds from their delivery to the ſound's reaching the ear: Sir Iſaac Newton ſays heavy bodies fall 16½ foot the firſt ſecond, then 3, 5, 7, 9, &c. times ſo much in the ſucceeding ſeconds, and that ſound moves 968 feet in a ſecond. Then $10'' \times 10'' = 100 \times 16\frac{1}{2}$, 1650 feet \div by 968 = $1'' 42'''$ for the approach of ſound. So the ſtone was falling but $8\frac{1}{4}''$; $8\cdot25 \times 8\cdot25 = 68\cdot0625 \times 16\cdot5 = 1123$ feet = 374¾ yards.

But

* PRIZE QUESTION.

This problem is of the nature of Sir I. Newton's 50th prob. in his Univerſal Arith. who has there given the true method of ſolution much in this manner.

Put x for the depth of the hole, $a = 16\frac{1}{2}$ feet the diſtance fallen by a body in the firſt ſecond of time, and $b = 1142$ feet = the velocity of ſound per ſecond; alſo t = the given time of hearing the ſound, found by the experiment.—Then, by the nature of

falling bodies, $\sqrt{a} : \sqrt{x} :: 1'' : \sqrt{\frac{x}{a}}$ = the time of the ſtone's falling to the bottom; and, by the uniform motion of ſound, $b : x :: 1'' : \frac{x}{b}$ = the time in which the ſound will aſcend through the ſpace x . Then the ſum of theſe two times will be equal to the whole time, that is $\frac{x}{b} + \sqrt{\frac{x}{a}} = t$. — Now

the times in which pendulums make an equal number of vibrations, being as the roots of the lengths, and a pendulum 39½ inches long vibrating 8 times in 8 ſeconds, we ſhall have $\sqrt{39\cdot2} : \sqrt{61} :: 8'' : 8\sqrt{\frac{61}{39\cdot2}} = 10''$ (extremely near) = t the time in which a pendulum of 61 inches ſwings 8 times: then the above theorem $\frac{x}{b} + \sqrt{\frac{x}{a}} = t$ becomes $\frac{x}{1142} + \sqrt{\frac{x}{16\frac{1}{2}}} = 10$. Hence $x = 1270\cdot4$ feet = 423½ yards = the depth required.

The theorem at the top of the next page I cannot reduce to a proper form, nor diſcover what the author means by it; it is evidently nonſenſe as it ſtands, but I have printed it exactly as I found it.

But by Dr. Hally's numbers, let $a = 16$ foot 1 inch, $b = 1142$ feet the motion of found, $t =$ the time, x the depth; there will arise this theorem,

$$x = \frac{abt \times \frac{1}{2}a}{b^2} \quad \frac{a}{2bh} \quad \sqrt{4bt \times 1} = 1265.82 \text{ feet.}$$

N. B. The method taught in *Lexicon Technicum*, and several authors, to find a depth by the falling of heavy bodies, is false. The time the found is reaching the ear, must be deducted out of the latter part of the stone's falling. In that author's example, under the word *pendulum*, according to the time of the body's falling, the well is 256 foot deep; then he allows for the found's ascending $\frac{1}{4}$ of 16 foot to be subtracted, makes it just 250 feet: whereas in the last second, the stone fell 112 feet, therefore $\frac{1}{4}$ of that (at least) must be deducted, it will be but 225 feet.

The prize of 10 diaries fell to Mr. Christ. Mason of London.

Of the Eclipses in 1723.

1. Sun eclipsed, Thursday the 23d of May, a quarter past 3 in the morning, invisible.
2. Moon eclipsed, June the 7th, at 4 in the afternoon, invisible.
3. Sun eclipsed, November the 16th, 3 quarters past 9 at night, and invisible.*

New

* This year, in the months of October, November, and December, a small new comet was observed by Mr. Bradley, Dr. Halley, and several others; from whose observations and calculations it appears that,

The inclination of its orbit and ecliptic was	—	49° 59' 0"
The place of the ascending node	—	♊ 14 16 0
The place of the perihelion	—	♊ 12 52 20
The distance of the perihelion from the node	—	28 36 20
The log. of the perihelion distance	—	9.999414
The log. of the diurnal motion	—	9.961007

The equal time of its being in its perihelion Sept. 16 d. 16 h. 10 m. In its orbit thus situated, the motion of the comet was retrograde or contrary to the order of the signs.

New Paradoxes.

Par. 1. There is a certain noted place in the vast Atlantic ocean, where a brisk Levant is absolutely the best wind for a ship that is to shape a due east course, and yet she shall still go before it.

Par. 2. It may be clearly demonstrated by the terrestrial globe, that it is not above twenty-four hours sailing from the river of Thames in England, to the city of Messina in Sicily, at a certain time of the year; provided there be a brisk north wind, a light frigate, and an azimuth compass.

Par. 3, by Mr. Richard Tapper.

A certain mount in Devonshire doth stand,
Whose lofty head o'erlooks the neighb'ring land;
And such is the known property o'th' hill,
That if a vessel you with liquor fill
At the hill's top or vertex of this place,
It holds less than if filled at the base.
Now what's the cause of this deficiency,
Pray let me know in the next diary.

Par. 4, by Mr. Christ. Mason.

When tyrant Noll, at fatal Worcester fight,
His crew harangu'd, against both law and right;
His quaint numerique no two did hear,
Tho' sev'ral thousand miscreants were there:
For ev'ry man, and ev'ry sev'ral ear,
Did not the same, but different voices hear.

New Questions.

I. Question 99, by Mr. C. Mason.

Two ancient towns, for two true lovers fam'd,
Abydos one, the other Sestus nam'd;
Thro' Abydos Leander's praises rung,
In Sestus they of Hero's beauty sung:
The Hellespont thote noted towns did part,
But was no bounds to love's unerring dart:
When she the greatness of her power display'd,
And such a wound at such a distance made.

But

But cruel fate their free access deny'd,
 And kept 'em pris'ners on each distant side.
 She was confin'd like Danae in a tow'r,
 Yet conquer'd was without a golden show'r:
 He so confin'd upon his native shore,
 No boats nor barges e'er durst waft him o'er.
 Each had a view of the adjacent lands,
 Plac'd opposite upon the lonesome strands.
 Tho' boist'rous furies did with envy roar,
 And dash with fury on the patient shore;
 His darling love wou'd no such bars allow,
 But naked stripp'd did on the billows plow:
 With speed he cut his proud triumphant way,
 As flut'ring waves did round his body play.

In equal times he equal spaces ply'd,
 Swift as the waves did o'er the channel glide;
 Each tow'ring wave the former did succeed,
 Just forty foot rolling with equal speed.
 If equidistant from each place you were,
 And the observation angle shou'd appear
 Just forty-three degrees; move t'wards 'em streight,
 Five furlongs just, the angle's forty-eight.
 The breadth o'th' Bosphorus I pray explore,
 Likewise the time he swam 'twixt shore and shore.

II. *Question 100, by Mr. John Richards.*

From Edystone viewing the neighb'ring shore,
 And willing to know how far it is o'er,
 To three ports within sight; their distances are known,
 From each other, as here under I have shown.
 I thought the best I cou'd do was to try,
 Which way from the rock those three places lie;
 This I have done, and it is noted here.
 Pray what will the three distances appear?

The distance from $\left\{ \begin{array}{l} \text{Plymouth to Lizard 60} \\ \text{Lizard to Start Point 70} \\ \text{Start Point to Plymouth 20} \end{array} \right\}$ miles.

$\left\{ \begin{array}{l} \text{Plymouth} \\ \text{Lizard} \\ \text{Start Point} \end{array} \right\}$ bears from Edystone rock $\left\{ \begin{array}{l} \text{North.} \\ \text{W. S. W.} \\ \text{E. b. N.} \end{array} \right.$

III. *Question*

III. *Question 101, by Mr. John Willingham.*

One evening from a mountain high,
 Soon as the sun was down,
 Looking towards the eastern sky,
 I saw the rising moon;
 Her distance from the zenith then,
 Streight way I did explore,
 And found degrees fourscore and ten,
 And fifty minutes more.
 A tube inclining one degree,
 And minutes fifty-eight,
 Thrō' which a ship appear'd at sea,
 Full crowding on my sight:
 The distance of that ship, o'th' main,
 In leagues I do require,
 Likewise what height above the plain
 That mountain does aspire.

IV. *Question 102, by Mr. John Simmons.*

In mason's yard there happened to roll
 A pyramid's frustum into a plashy hole,
 Whose bases are (in form) octagonal. }
 The less base sides just touch'd the water's brink,
 The greater base did wholly in it sink;
 So that the level surface of the water
 Did nicely cut (or very near the matter)
 The frustum with a line diagonal.
 Being thus immers'd, I cou'd not take all
 Usual dimentions; which made me fret, }
 'Cause I each part's solidity must get,
 Both of the dry, in inches, and the wet.
 To help me out a friend gave me a line,
 That was divided in extream and mean:
 The greater segment was the length o'th' side,
 Less base's breadth the other; — he also said,
 That base and side an obtuse angle making,
 Of just fivescore degrees (when 'twas taken)
 And this the frustum's whole solidity. 158821'64 }
 I've lost the line, and the task's too hard for me;
 Ladies—Pray solve the same in your next diary. }

V. *Question*

V. *Question 103, by Mr. Will Doidge.*

Of you, fair ladies, I a favour sue,
 'Tis your bright genius must resolve it too.
 I in a garden have a piece of ground
 In oval form, the transverse I have found
 Just fifteen feet, the conjugate was ten;
 An ordinate which cuts the transverse length,
 From off the center just three feet two-tenth;
 Not rightly apply'd, but inclined laid,
 And sev'nty-two degrees an angle made.
 What length each part is from the transverse axe,
 Of you, bright wits, I with submission ask.

VI. *Question 104, by Mr. Tho. Williams.*

Wand'ring Æneas, long with tempests tost,
 Was thrown upon the famous Libyan coast,
 Where mighty Carthage stood, and Dido queen,
 Late come from Tyrus with her slender train.
 This splendid town (a village late) they view,
 Whilst Tyrians do their daily task pursue,
 And dig foundations for their building masters,
 Hewing out and making fine pilasters.
 One stone among the rest was fixed there,
 Of polish'd marble wrought, its base four-square;
 Its curious shape was pyramidal;
 Its lofty height twice the diagonal:
 And whilst Æneas view'd this finish'd stone,
 The mason said, Thou pious mighty son
 Of old Anchyses, by the foot 'twas made,
 But being unmeasur'd, I am still unpaid;
 And must be so, unless some artist's skill,
 More than my own, that task for me fulfil.
 Its weight is just forty-eight tun complete;
 But how from thence to find its solid feet,
 I know not; but desire that, aiding, you
 Wou'd that and its dimensions shew.

The Prize Question.

When brilliant wits the splendid forms wou'd shew
 Of nicest architecture to our view;
 Nothing near home is worthy of their note,
 But all's fetch'd from those kingdoms more remote.

Rome

Rome, Egypt, Italy, or ancient Greece,
 Is art's as well as nature's master-piece;
 Magnificent their turrets, pyramids
 Rearing above the clouds their lofty heads:
 Their putrid waters must be crystalline,
 Their common pebbles orient pearls out-shine;
 Their verdant meads from pinching frosts be free'd,
 And never-fading blooms the trees o'erspread.

Thus the fantastic humours of the age
 Delight themselves, and all their thoughts engage
 To things of foreign growth, or antic mien,
 Neglecting what's more easy to be seen.
 If from the heathen poets tales they tell,
 It proves a modern proper vehicle,
 To pass the airy gilded phantom down,
 Pall'd with more worthy objects of their own.
 Strangely deprav'd such fleeting fancies are,
 And like weak eyes distinguish nothing near
 Without their optic glasses; but from far
 Mistake a lamp for Titan's rising car.

Yet stately structures thus describ'd we prize,
 And much relent we shou'd those rules despise
 The Romans brought; and, in the Gothic way,
 Without a rule or order, art display.

But notwithstanding that, we may behold
 Amongst us buildings beautiful and old;
 Westminster Abbey, and St. Peter's, York,
 King's College, Cambridge, admirable work;
 And, tho' less fam'd, as justly may admire,
 Amongst the rest, that noble lofty spire
 To the Botoners honour built in Coventry,
 Second to none in sprightly symmetry,
 Only o'er-top'd in height by Salisbury.
 In ev'ry part it entertains the eye
 With statuary work, and fine embroidery:
 Yet full of strength and grandeur, that it seems
 A geometric mean, 'twixt two extremes.

And altho' mathematic instruments
 Furnish with methods for its full extents;
 I'll here propose, from algebraic art,
 And from a theorem Euclid does impart,
 To find its height, without the help of those,
 And freely tell the rule that I have chose.
 " An ancient house there stood in a low place,
 " Whose top's exactly level with the base,
 " Or steeple's bottom: then I take my stand
 " A distance off, but still on lower land;

To

" To th' house and spire I my eye confine,
 " And find it runs directly in a line;
 " And distant from the foot along the ground,
 " Two hundred and eighty-two feet two-tenths is found; 282'2
 " The horizontal line, from the house-top must be
 " Just the same numbers you i'th' margin see.* * 228½
 " That from my eye to th' top, I do declare,
 " Added to th' highest perpendicular,
 " In feet these numbers will exactly give,
 " Four cents, above seven hundred seventy-five. 775'04

1724.

Paradoxes answered.

Paradox 1 answer'd.

IF the place be eastward of the Levant, a ship may be carried by an east wind round the globe to it; provided some east point be fix'd. *Ja. Wylde.* Or, where there is a violent tide. *Oedipus Sebastianus.* 'Tis meant the gulph of Florida. *J. Richards, T. Gill.* But the quibble may lie in the word *shape*, for an east wind may be best for carrying her out of an harbour to sail to a place on the eastern part of that island or continent.

Par. 2. Is meant the artificial globe and the hand index.

Par. 3. Water has its surface always of a spherical figure; and that farthest from the earth's center is least swelling, and consequently holds least above the brim of the vessel.

Par. 4. Sound being efflated in concentric circles, as a stone falling into water moves it all round, so that part of a circle which touch'd one man's ear, could not touch another's who cou'd not be in the same individual spot of ground.

Questions

Questions answer'd.

* I. *The 99th Question answer'd by Mr. Rich. Tapper.*

As the rectangle of the radius and the sine of $2^{\circ} 30'$: the rectangle of the sines of 24° and $21^{\circ} 30'$:: $3300 = 5$ furlongs : half the breadth of the Bosphorus $11277^{\frac{1}{2}} 764613$ feet. The whole breadth is $7515^{\frac{1}{2}} 1764$ yards = 34 furlongs 35 yards = 4 miles 2 furl. 35 yards. Then (according to Sir Isaac Newton) a wave runs thro' its breadth, whilst a pendulum, whose length is equal to that breadth, oscillates or vibrates once. A pendulum of 40 feet in length vibrates $17^{\frac{1}{2}} 14642817$ times a minute. Consequently he swam $68^{\frac{1}{2}} 85$ feet per minut.. From hence the time is $32' 53'' 11''' 52''''$.

The proposer and some others give the answer $7518^{\frac{1}{2}} 7$ yards, and the time 33 min. or $32^{\circ} 90' 39''$.

II. *Question*

* I. QUESTION 99.

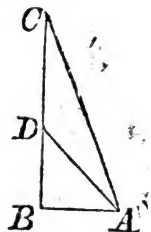
If C and D represent the two places of observation, and AB half the breadth of the Bosphorus : then we have given all the angles and the line CD , to find AB ; viz. $\angle C = 21^{\circ} 30' =$ half the first observed angle, $\angle BDA = 24^{\circ} =$ half the latter, $\angle DAC = (\angle D - \angle C) = 2^{\circ} 30'$, and $CD = 5$ furlongs = 3300 feet. — Hence, by common trigonometry,

s. $CAD : s. C :: CD : DA$, and

radius : s. $D :: DA : AB$; hence by compounding these two proportions, &c.

radius \times s. $CAD : s. D \times s. C :: CD : AB$, that is

radius \times s. $2^{\circ} 30' : s. 24^{\circ} \times s. 21^{\circ} 30' :: 3300$ feet : half the breadth of the Bosphorus, as in the original solution.



Again, by the nature of pendulums, $\sqrt{\frac{39^{\cdot}2}{12}} : \sqrt{40} :: 1'' :$

$\sqrt{\frac{40 \times 12}{39^{\cdot}2}} = \frac{10\sqrt{6}}{7} = 3\frac{1}{2}$ seconds, very nearly, = the time in which a pendulum of 40 feet makes one vibration, or = the time in which the wave or the swimmer moves 40 feet. And, consequently, as 40 feet : $3\frac{1}{2}'' ::$ the whole distance : time of swimming.

Diary Math.

Y

II. *Question 100 answer'd by Mr. John Topham.*

This question is to be found in Philosophical Transactions, propos'd by Mr. Townley, with Mr. Collins's constructions to all its cases. From Edyſtone to Lizard $53^{\circ}112$ miles, to Start Point $17^{\circ}134$, to Plymouth $14^{\circ}187$.

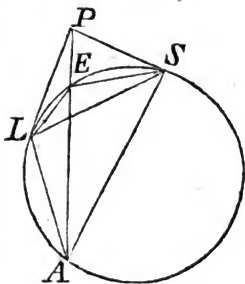
The question being somewhat curious, I ſhall here give the method of ſolving it. Becauſe any two of the angles anſwering the rumb's given in the queſtion, exceed 180 degrees, the point where Edyſtone ſtands muſt fall within the triangle. Then if you ſuppoſe a circle to paſs thro' Lizard, Edyſtone, and Start, and biſect the line between Lizard and Start,

* II. QUESTION 100.

Another method of conſtruction and calculation may be thus.

Conſtruction.

With the three given diſtances, 60 , 70 , and 20 , make the triangle LPS , wherein P will be Plymouth, L the Lizard, and S the Start. Then if E be ſuppoſed to repreſent the Edyſtone, the direction EP being North, ES being E. by N. and EL being W. S. W. there will be known all the angles about the point E . Hence, ſuppoſing PE produced to A , if on LS there be deſcribed the ſegment of a circle LES to contain the given angle $LES = 15$ points or $168^{\circ}45'$, and then there be made either the angle $SLA = 9$ points $= \angle AES$, or the angle $LSA = 6$ points $= \angle AEL$, LA or SA cutting the circle in A ; it is evident that E will be the point of interſection of AP with the circle.

*Calculation.*

1. In the triangle LPS , are given all the ſides, and of conſequence the angle PSL . — 2. In the triangle ALS , are given LS , the $\angle ASL$ (by conſtr.) and the $\angle A =$ the ſupplement of $\angle LES$; to find SA . — 3. In the triangle PSA , are given PS , SA , and $\angle S$; to find $\angle PAS = \angle SLE$, and $\angle APS$. — 4. In the triangle LES , are given the angles and the ſide LS ; to find LE and ES . — 5. And, laſtly, in the triangle PSE , are given the angles and the ſide SP ; to find PE .

Start, producing such line through the center of that circle to the periphery, lines drawn from the point in the periphery to Lizard and Start, with the two lines from Edyftone to Lizard, and from Edyftone to Start, will be a trapezia inſcrib'd in a circle, which according to 22 Euclid 3, the two oppoſite angles taken together are equal to two right angles; conſequently the angle at the periphery is $11^{\circ} 15'$, the complement to that at Edyftone $163^{\circ} 45'$ given. In like manner, let a circle paſs through Plymouth, Edyftone, and Lizard, the angle at the periphery will be $67^{\circ} 30'$, the complement to the other rumb given, $112^{\circ} 30'$. Again, if from the center of the firſt circle you draw lines to Lizard and Start, the angle contain'd between them will be double to that at the circumference, by 20 prop. Euclid 3, viz. $22^{\circ} 30'$, and in the other circle 135° . Then,

s. $11^{\circ} 15'$: log. of $\frac{1}{2}$ 70 miles given :: radius : femi-diam. circle 179.4. Alſo,

s. $67^{\circ} 30'$: log. of $\frac{1}{2}$ 60 miles given :: radius : femi-diam. circle 32.47.

Now there is given the two femi-diameters of the circles, and the angle between them = $116^{\circ} 38'$, to find the angle ſubtended by the leſſer femi-diameter.

As ſum ſides : difference :: tang. $\frac{1}{2}$ oppoſite angles : tang. of $\frac{1}{2}$ the difference of the angles; which angle is $8^{\circ} 31'$. Then radius : log. 179.3 :: s. $8^{\circ} 31'$: log. of 26.52; which doubled is the diſtance between Edyftone and Lizard 53.04 miles. For the other two, there are 2 ſides, and an angle oppoſite to one of them, given, to find the other ſide. Hence from Edyftone to Plymouth is $14^{\circ} 333$ miles, and from Edyftone to Start Point $17^{\circ} 36$.

III. *Queſtion 101 answer'd by Mr. Tapper.*

As radius : the ſecant of $50'$:: femi-diam. earth : the femi-diam. and height of the mountain in one ſum. Sem. earth : s. $88^{\circ} 2'$:: laſt ſum : s. angle oppoſite $91^{\circ} 47'$. Conſequently the angle at the center is known.

If the diameter of the earth be, as Norwood makes it 41899310 Engliſh feet, the mountain's height will be = 2216.473 feet, the ſhip's diſtance $14^{\circ} 6288$ miles, and from the baſe of the mountain on the arch of a great circle $12^{\circ} 726$.

N. B. The propoſer gives this answer, viz. The mountain's height 746 yards $\frac{1}{2}$, at 70 miles to a degree; the ſhip's diſtance 3 leagues 2 miles. But ſome others, accord-

ing to the difference of miles to a degree, 881 yards and 5 leagues, &c.*

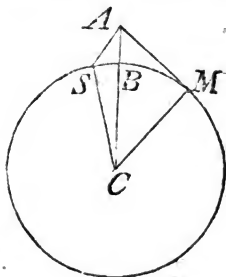
† IV. *Question 102 answer'd by the same.*

Let $a = 82847$, the area of an octagon whose diameter is r , $C =$ content of the frustum, $s =$ sine 10° , $c =$ its cosine, $r =$ radius, $x =$ diameter of lesser base, $y =$ the slant side of the frustum more the lesser base; then $axx =$ the area of lesser base, and the slant height $= y - x$. Therefore $y : y - x :: y - x : x$ by the nature of the line.

And

* III. QUESTION 101.

The above original solution will be evident from this figure; in which C represents the center of the earth, AB the hill, S the ship, and AM a tangent to the earth directed to the rising moon. For, M being a right angle, and $\angle ACM = 50'$, whose tangent is MA and secant AC , it will be as radius : sec. $\angle ACM :: CM : CA$. — Again, the $\angle SAC$ being $= 88^\circ 2'$, and the sides CS , CA known; we thence find the third side $AS =$ the distance of the ship from the top of the mountain; as also the $\angle SCA$, and consequently the arch SB the distance of the ship from the bottom of the mountain.



† IV. QUESTION 102.

The solution to this question will perhaps appear a little clearer thus.—The slant side being the greater part, and the diameter of the circle inscribed in the less end the less part of a line divided in extreme and mean proportion; the meaning of which is, that the greater part is a mean proportional between the less part and the whole, that is $xx = x + y \times y = xy + yy$, putting $x =$ the greater part or the slant height, and $y =$ the less or the diameter of the circle in the less end. Now from this quadratic equation is found $y = \frac{\sqrt{5-1}}{2} x = ax$, putting $a = \frac{\sqrt{5-1}}{2}$.

Now, the slant side making an angle of 100° with the less end, or of 80° with the greater, put s and c for the sine and cosine of 80° ; then sx will be the altitude of the solid, and cx the half difference

And $yy - 2yx + xx = yx$. Hence $y = 1.5 + \sqrt{\frac{1}{4}x}$.

And $y - x = .5 + \sqrt{\frac{1}{4}x}$ = the slant side.

As radius : $.5 + \sqrt{\frac{1}{4}x} :: r : \frac{.35 + r\sqrt{\frac{1}{4}x}}{r}$ = the half difference of the breadths of the two bases. And consequently

$1 + \frac{.5 + 2r\sqrt{\frac{1}{4}x}}{r}$ = the breadth of the greater base = bx .

Then the area of the greatest base = $abbxx$, and the geometrical mean area = $abxx$. Then

As radius : $.5 + \sqrt{\frac{1}{4}x} :: c : \frac{.5c + c\sqrt{\frac{1}{4}x}}{r}$ = the altitude of the frustum = dx . And by multiplication we have

$\frac{1}{3}adx^3 \times bb + b + 1 = C = \frac{1}{3}$ of the three areas multiplied

by dx the height = mx^3 . And hence $x = \sqrt[3]{\frac{C}{m}} =$

41.633534 inches. Then making the square root of the area of the lesser base = d , the greater = D , the height = H .

$DD + \frac{DDd}{D+d} \times \frac{1}{3}H = 107707.75$ the wet part.

By J. Painter.

107784.57

$dd + \frac{ddD}{D+d} \times \frac{1}{3}H = 51113.89$ the dry part.

51637.07

Breadth of lesser base — — — 41.6335

Side of lesser base — — — 17.2451

Breadth } of greater base — { 65.0286

Side } { 26.9357

Altitude — — — — 66.3410

Slant height — — — — 67.3674

Area of { lesser base — — 1435.9551

{ greater base — — 3503.2256

41.6641

17.2530

65.0720

26.9524

66.3290

67.4040

1437.66

3507.19

V. Question

ference between the diameters of the two ends; and consequently $y + 2cx$ or $ax + 2cx$ = the diameter of the circle in the greater end = bx , putting $b = a + 2c$. — Then, putting n for the area of the octagon, the diameter of whose inscribed circle is 1, we shall have na^2x^2 and nb^2x^2 for the areas of the two ends, and $nabx^2$ their mean proportional; hence the content will be

$$sx \times \frac{na^2x^2 + nabx^2 + nb^2x^2}{3} = 158821.64 = d, \text{ from}$$

which is found $x = \sqrt[3]{\frac{3d}{ns \times aa + ab + bb}}$. Consequently all the parts become known, and thence the content of each hoof as in the original solution.

Y 3

* V. *Question 103 answer'd by Mr. J. Painter.*

The length of the greater part of the ordinate 5'18, and the lesser 4'23.

By Mr. Tapper, 5'13416 and 4'20625.

† VI. *Question 104 answer'd.*

A cubic inch of marble weighs 1'56185 ounces avoirdupois, so the content of the pyramid is 634'5729257 solid feet. The proportion of the side of a square to its diagonal, is as 1 to 1'4142. Multiply the solid content by 3, and divide the product by 2, gives 952'782, which multiplied by the square of 1'4142 = 1'99936, gives 1906, whose cube root is 12'319, the diagonal. Divide 952'78 by 12'31, gives 76'89, whose square root 8'768 is the side of the square sought.

The

* V. QUESTION 103.

Let DD be the line cutting the transverse AB in an angle of 72 degrees at the point E ; draw the perpendiculars DF .

Put m = semi-transverse, n = semi-conjugate, $a = CE$, s and c = sine and cosine $\angle E = 72^\circ$, and $x = DE$.—Then $DE = sx$, $EF = cx$, and $CF = a \pm cx$; hence, by the nature of the ellipse, $m^2 : n^2 ::$

$$m + a \pm cx \times m - a \mp cx :$$

$$s^2 x^2 = n^2 \times \frac{m^2 - a^2 \pm 2acx \mp c^2 x^2}{mm}; \text{ this equation reduced becomes}$$

$xx \pm 9282248x = 215945$; hence $x = 4'206$ or $5'1342 =$ the two parts required.



† VI. QUESTION 104.

The content being found as in the original solution above, put it = c , and x = the side of the square base. Then xx = the area of the base, $x\sqrt{2}$ = the diagonal, and $2x\sqrt{2}$ = the height.

Hence the content $\frac{2x^3\sqrt{2}}{3} = c$; then $x = \sqrt[3]{\frac{3c}{2\sqrt{2}}}$ = the side of the base, and $(2x\sqrt{2}) = \sqrt[3]{24c} = 2\sqrt[3]{3c}$ = the height.

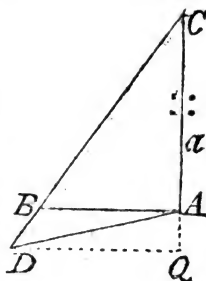
* *The Prize Question answer'd by J. Painter.*

Put $CA + CD = 775.04 = s$,

$AD = 282.2 = d$, $AB = 228.75 = b$;

Substitute $2x = ss - dd$,

Which by the process in Ward's Math. Guide, p. 336, at the 21st step, you will have



$$\frac{ssaa - 23a^3 + a^4}{bb + aa} = \frac{xx - 2xsa + 2xaa + ssaa - 2sa^3 + a^4}{aa}$$

Which

* PRIZE QUESTION.

The process for finding the equation in the above original solution, may be thus :

Put $s = AC + CD$, $b = AB$, $d = AD$, and $z = AC$ the height of the steeple; then $s - z = CD$. Draw DQ perpendicular to CA produced in Q .—Now, by right-angled triangles, $BC = \sqrt{bb + zz}$; and, by similar triangles, $CB : CD$

$$\therefore \left\{ \begin{array}{l} CA : CQ = \frac{s-z}{\sqrt{bb+zz}} z \\ AB : QD = \frac{s-z}{\sqrt{bb+zz}} b \end{array} \right\}; \text{ hence } QA = QC - CA$$

$= \frac{s-z}{\sqrt{bb+zz}} z - z$; and then, by right-angled triangles again, $dd = AQ^2 + QD^2$, which equation reduced, and $2aa$ written for $ss - dd$, we have

$$\left\{ \begin{array}{l} + 2a^2 \\ + b^2 \end{array} \right\} z^4 - \left\{ \begin{array}{l} 2a^2 s \\ 2b^2 s \end{array} \right\} z^3 + \left\{ \begin{array}{l} + a^4 \\ + 2a^2 b^2 \\ + b^2 s^2 \end{array} \right\} z^2 - 2a^2 b^2 sz = a^4 b^2, \text{ which is the equation required.}$$

Which being reduced by multiplication and transposition, will stand, $-bba^4 - 2xa^4 + 2sbb a^3 + 2xsa^3 - 2bbxaa - bbsaa - xxaa + 2bbxsa = xxbb$. In numbers, $-573376.72a^4 + 484945075.246a^3 - 126569950746.798aa + 21131282571666.926a = 3351576300531368.689$. If the terms be divided, it will stand, $-a^4 + 845.77a^3 - 220744.848aa + 36854112.9a = 6192379528.849$.

From hence will be found a the height of the steeple = 310.8409 feet.

But if there had not happen'd a mistake in the last line in printing the question, which should be 755.04, the answer had been 300 feet, the true height of Coventry spire, as I actually measur'd it both by lines and instruments, Sept. 26, 1721.

A Letter to the Author.

S I R,

I have oftentimes thought the composition of the enigmas and questions might be improved, and was therefore mightily pleased to see in your last year's diary such useful and necessary hints for the composing a proper enigma. But I have often privately complain'd that arithmetical questions have been very dubious and unintelligible; and therefore could wish some necessary directions were laid down, to guide persons of a good mathematical genius to a proper way of diverting their thoughts upon such occasions. And,

1. The most natural method in answering the questions, should be a little regarded in the composition.
2. No question that can be answer'd two ways should be allowed of, which will necessarily lead some from the expected answer.
3. Nothing that is very paradoxical, much less naturally impossible, and void of demonstration, should be put for an arithmetical question.
4. No ambiguous or doubtful words should be used, but such as are plain and easy to be understood.

5. We

5. We should use the same terms of art with the late and best authors; or at least our terms and phrases should be so plain and easy, as that none may be mistaken or deceived by them: for I think it is much better and more improving, to invent something ingenious than abstruse. Nor do I see any great benefit or difficulty in puzzling mankind, and racking their brains; nor is it necessary, when there is such an infinite variety in the mathematics of pleasant and profitable propositions. All kind of learning is difficult enough, especially the mathematical, to take up the short interims of our time, without being made more tedious and laborious; therefore we should make it our chief aim to facilitate and abridge it.

T. FLETCHER.

Of the Eclipses in 1724.

1. Moon eclipsed, Monday, April 27, 8 morn. invisible.

2. Sun eclipsed on Monday the 11th of May, at half an hour after 6 in the evening, almost total, and visible. This will be the greatest eclipse that will happen in England for these 50 years.

The general eclipse (in respect to the meridian of London) begins at 52 minutes past 2; the central shadow enters on the earth in lat. $13^{\circ} 36'$, in long. $226^{\circ} 46'$; whence it proceeds with a velocity of about 40 miles in a minute north-eastwards, along the west sea, and over California, Nova Granada, and the northern parts of America, toward Terra Arctica, and Hudson's Bay, where it tends towards the east, and passeth Terra Cunadensis, by Nova Francia, the Gulph of St. Laurence to Newfoundland; then traverses the north sea to Europe, enters France about St. Malo, and proceeds along by Le Mans Blois, Bourges, and Challon-sur-foane, and having pass'd through the north parts of Italy, by Geneva, and borders of Switzerland, over the Alps; by Palanza, Como, and Brescia, it leaves the earth between Mantua and Rovigo.

J. Willingham.

Mr. *Joseph Smith*, of Fleet in Lincolnshire, from a geometrical construction and a calculation, sends the following account of the sun's eclipse at Holbeach: begins 5 h. 41', mid. 6 h. 37', end 7 h. 29'. At Stockholm in Sweden, begin 6 h. 51', mid. 7 h. 42', ends 8 h. 27'. Digits eclipsed 8 $\frac{12}{12}$ south. At Bermudas in the West Indies, begin. 12 h. 43', mid. 1 h. 43', ends 2 h. 33'. Digits 3 north.

In lat. 2° 48' north long. 132° 30' west, at 5 h. 55', the eclipse will begin at the sun's rising. Lat. 13° 50' north long. 151° 18' west from Holbeach, in the south sea, the sun will be centrally eclipsed as he riseth.

Lat. 51° 48' north long. 89° 47' west, at 11 h. 19', the sun will be centrally eclipsed in the 90th degree at Canada, or New France in America.

In lat. 54° 19' long. 82° 47', part of Hudson's Bay, the sun will be centrally eclipsed in the meridian.

In the lat. 45° 16' long. 11° 50', parts of Mantua in Italy, the central eclipse will end. In lat. 34° 48' north long. 10° 31' west, the Atlantic ocean near Gibraltar, the eclipse ends.

☉ Eclip. 11 May, 1724, even.		Beg.	Mid.	End	Dig.
		h.			
By Astron. Carol.	Coventry	V 38	VI 34	VII 26 $\frac{1}{2}$	XI 31
Mr. Chattock	London	5 39	6 36	7 23	12 7
	Coventry	V 32	6 29	7 23	12 0
Dr. Halley	London	5 39	VI 35 $\frac{1}{2}$	VII 27 $\frac{1}{2}$	— —
Mr. Richards	Exeter	5 25	6 18	7 11	12 2
Mr Smith	Holbeach	5 41	6 37	7 29	11 30
.....	London	5 38	6 35	7 29	11 47
Mr. Willingham	Myton York	5 36	6 30	7 22	11 5
Mr. Gill	Worcester	5 31	6 27	7 20	11 51
Mr. Child	Northampt.	5 40	6 36	7 28	11 30
Mr. Williams	Oxon	5 35	6 31	7 23	— —
Mr. Warner	Wellingbor.	5 39	6 36	7 29	11 37
Mr. Leadbetter	London	5 39	6 36	7 25	11 45

This eclipse will not be total, but at the greatest darkness there will be a small thread of light on the upper part of the sun's body, just a 24th part of his diameter or breadth. But some of the stars will be discern'd. The planets ♄ in the south-east, ♀ nearer the south, and ♃ on the left-hand, the sun a little higher.

3. Moon eclipsed, October the 21st in the morning.*

	h.	Leadb.	J. Paint.
Beginning by Adraſtea's calcul.	II 30	2 52	2 33
The middle at — — —	III 47	4 8	3 52
The end at — — —	V 4	5 24	5 16
Digits eclipsed north — — —	7 16	7 4	6 12

4. Sun eclipsed, November 4, at 11 at night, inviſible.

New

* This eclipse was obſerved thus :

1. At Gomroon in Perſia by Mr. W. Sanderſon.

The moon entered into the dark ſhadow or umbra of the earth
at 11 min. 33 ſec. paſt five, Ante Meridiem.

2. At Rome by Blanchini.

Temp. Ver.

h. m. s.

3 15 40 Initium umbræ veræ.

5 48 50 Finis umbræ veræ.

3. At Liſbon by John Baptiſta Carbone, and Dominico Capaſſo.

Temp. Ver.

h. m. s.

1 38 0 Penumbra incipit eſſe ſenſibilis.

1 47 45 Umbra incipit.

4 20 36 Finis eclipſis.

4 28 0 Definit penumbra ſpiſſior.

4. Other obſervations in Britain, taken from the Diary for the
next year (1725).

	Begin.	Midd.	End	Digits
		h. m.	h. m.	
At Wyken in Warwickſhire —	- -	6 31	7 28	11
By Mr. Lawry, Cornwall —	- -	6 22	7 20	12
Mr. Tapper, Briſtol, continued } in total darkneſs 2 1/2 m. — }	- -	6 28	- -	12
Mr. Child, Newport Pagnel —	5 40	6 35	- -	-

New Questions.

I. *Question 105, by Mr. Williams.*

When fam'd Europa's son, Minos the just,
 Besieg'd Megæra's tower with his host,
 Whose sounding walls, moted around, did stand,
 Erected by Apollo's sacred hand.
 This Nisus held, whose purple hair, 'tis said,
 Contain'd their safety, till it was betray'd
 To Minos, by his daughter's am'rous aid. }
 For whilst she view'd his practis'd chivalry
 From off the tower, she trembling thus did say:
 " Inforc'd by love, this tower I intend,
 " To render up, and give these wars an end.
 " Did not Petrea's daughter, with like flame,
 " Venture like hazards for Amphitryo's name?
 " Then why should Scylla less advent'rous prove?
 " Love conquers all things; all must yield to love."
 This said (Pallas assisting her) she made
 Of ropes a ladder, and by Cupid's aid
 Convey'd it to her love upon the shore,
 Who it ascends, and so he gain'd the tower.
 Now you'll expect, since I'm historian grown,
 The tower's height; and that may thus be known:
 For if 'tis multiply'd by * ninety-three, * 93 feet
 The breadth o'th' moat, and the product added be
 To twice the ladder's length, 'twill make these feet,
 Fourteen thousand four hundred twenty-three, compleat.
[14423]

II. *Question 106, by Mr. John Richards.*

Being taking a glass with some friends of the town,
 The exciseman came in, whom we ask'd to sit down;
 He did so, and as we did freely converse,
 Our new friend began the following discourse.
 " That spheroidal cask (says he) on that stiller,
 " Is more artfully made than any i'th' cellar;
 " For whether you work by Mr. Oughtred's canon,
 " Or multiply the difference by seven-tenths (as is common
 " For us gaugers, when hasty, to do in the case)
 " 'Twill bring out the same equal cylinder's base.
 " The length of the cask's forty inches five-tenths,
 " And ninety-eight gallons I make the contents."

The

The vessel lay level, the bung being up,
 The liquor was eleven inches deep from the top.
 I ask'd if he knew how to ullage the cask;
 Alack, sir, says he, that's no very hard task.
 I question'd his skill; this nettled the gauger,
 Who presently offer'd to lay me a wager,
 That he'd tell to a spoonful the liquor's content:
 'Tis done, sir, (says I) for a crown to be spent.
 He consulted such authors as merit regard,
 For the ullaging part; as Hunt, Jones, and Ward.
 And having gone thro' with the whole operation;
 I found none of his methods would bear demonstration:
 So demanding the crown, he refuses to pay,
 Till I shew him a more mathematical way.
 Now for sake of the gains, I'd soon do't if I could,
 But seeing I cannot, I beg that you would.

III. *Question 107, by Mr. A. Naughley.*

Fair ladies, if you I must yet enquire
 How the poll stood for the knights of our shire.
 The number of voices, as I have seen,
 Was five thousand two hundred and nineteen.
 Which among four was just so divided,
 As one the second and third exceeded
 By twenty-two and fourscore bating seven,
 The fourth by no more than sixscore and ten:
 Then how many votes had each candidate;
 You can't in finding much trouble your pate,
 But yet I'd have a general rule for that.

}

IV. *Question 108, by Mr. Richard Whitehead.*

Suppose four brothers represented be
 By these four letters, *A, B, C,* and *D*;
 And each of them unequally to share
 A right-lin'd field, in form triangular;
 Two shortest sides of which the page does show,
 But for its base, it's what I do not know.
 An oblong does possess the middle space,
 Touch'd by two sides, and lying on the base,
 Whose length in perches is in margin seen,
 And its breadth, or height, is just eighteen:
 The other shares do in each angle lie,
 And their contents are what you're to descry.

Diary Mathem.

Z

perches
 $65\frac{1}{2}$
 $52\frac{8}{9}$

$46\frac{2}{3}$

C takes

C takes the oblong, being the greatest space;
B takes the angle opposite the base;
A's on the left, *D*'s on the right does fall;
 He being youngest, had the least of all.
 I, who have ever loving prov'd and true,
 Do for your answer, ladies, humbly sue.

V. *Question 109, by Mr. Wm. Doidge.*

One summer evening, as I walk'd alone,
 I heard a damsel making piteous moan:
 I ask'd this fair the cause of so much grief,
 If I cou'd give her troubled mind relief.
 With sighs and tears she did her case explain;
 ' Oh! cruel love's the cause of all my pain.
 ' A spark, in whom external beauty shin'd,
 ' Hath won my heart, hath stole away my mind:
 ' That we shou'd wed my father gave consent;
 ' To live in joys and pleasures permanent.
 ' But ah! that happy day it must not be,
 ' Till this equation * and my age agree.
 ' All ways we've try'd, but all our labour's vain,
 ' To know my age, and cure me of my pain.
 ' ' Cease, cease, fair maid, your mournful tears, (said I) }
 ' To the ingenious ladies I'll apply, }
 ' Whose skill in figures' seen i'th' diary.'

Ladies, consider love's tormenting pain,
 Leave not this fair one longer to complain:
 Tell her what age she will be made a bride,
 When she'll be happy by her lover's side.

$$* \frac{\sqrt[2]{aaa} - \sqrt[3]{aa}}{4.962} = a = \text{her age.}$$

VI. *Question 110, by Mr. George Brown.*

Upon the northern seas, where boist'rous storms did rise,
 And darksome clouds obscur'd the azure skies,
 And from our sight all its celestial bodies skreen,
 That day or night to us could not be seen.
 During which time, our gallant ship was tofs'd
 'Midst rocks and sands, each minute cast for lost,
 Where every billow did present a grave,
 And death triumphant rode on ev'ry wave.
 When in the height of sorrow, fear, or doubt,
 The storm allay'd; and to our joy bright Sol look'd out;
 Whose

Whose altitude was taken in the heav'n,
 And prov'd thirty-nine degrees, and minutes sev'n.
 The calm continu'd, and in that very place
 We stay'd an hour and fifty minutes space;
 And then bright Phœbus smil'd on us once more,
 His altitude again we did explore.
 By our accounts, we found that very day
 Fell out exactly on the tenth of May.

55° 57'

Now, ladies fair, whose wits are ripe at will,
 In this distress, I pray exert your skill;
 And from what here is found, gave me, I pray,
 The latitude o'th' ship, and hours o'th' day.

The Prize Question, by Adrastæa.

When poets feign Atlas the world cou'd bear,
 And giant great Goliath wield the spear:
 Prodigious bulk! And Archimedes move,
 With his machine, the lofty seat of Jove.
 We stand amaz'd, when they such things rehearse,
 About the vast expanse o'th' universe.

Geographers do little less pretend
 The faults and errors in the globe to mend:
 Will all its parts, seas, creeks, and bays unravel,
 Tho' they no farther than their garrets travel.

I only have one county measur'd over,
 It's hard enough all parts for to discover;
 With curious theorms by old Euclid shown,
 And instruments as heretofore unknown.

At the interfection of two Roman ways,
 Cut thro' this kingdom in their Cæsars days,
 And by them nam'd the Watling-street and Fosse;
 There stood Bennones, which now we call High Cross.
 From thence (nearly) in a straight line I come
 Unto Dove Bridge, or fam'd Tripontium;
 Bearing almost south east by south: The whole
 Was just eight mile, one furlong, and five pole.
 To Eathorpe I perambulating go,
 The line is perpendicular I know;
 But turns and windings, till the Fosse I met,
 Will not its horizontal distance get.
 In a straight line the Fosse I measur'd, till
 I reach'd a tumulus call'd Brinklow-hill:
 Designing once again High Cross to view,
 And by my clock-work found I'd measur'd true,
 Eight miles, seven furlongs, and poles twenty-two:

Z 2

Tripona.

Tripontium then was just within my sight,
 A line drawn to it made an angle right:
 With this perpend. and what before I've shown,
 The triangle compleatly may be known.

From Tripontium the river Avon I survey'd,
 Which many curious turns and windings made.
 Close by stands Newbold, eminently high,
 Whence those three places mention'd I cou'd spy:
 'Twixt first and second, the angles eighty-eight,
 Fifteen: Eathorpe from the bridge call'd Dove, $88^{\circ} 15'$
 One hundred forty-nine, and forty-five did prove. 149 45
 From Eathorpe to Bennones, of consequence
 One hundred twenty-two degrees: From hence 122 0
 I cou'd adjust the distance to each place,
 And tell if Avon truly measur'd was.
 This to Geodesian's feldom known;
 Now tell the theorems by which they're shown.

1725.

Questions answer'd.

* I. Question 105 answer'd by Mr. John Painter.

LET $b = 93$, c = ladder's length, a = tower's height.
 Then is $ab + 2c = 14423$ per question, and $aa + bb = cc$, 47 Euc. 1. There will arise this ambiguous equation
 $a = \frac{1}{2}d + \sqrt{\frac{1}{4}dd - z} = 151'2688$ the tower's height; and
 the ladder's length = 177'57.

II. Question

* I. QUESTION 105.

The ladder being the hypotenuse of a right-angled triangle, whose base is the breadth of the mote, and perpendicular the height of the tower; if b be put = 93 the breadth of the mote, and x = the height of the tower, we shall have $\sqrt{b^2 + x^2}$ = the ladder; and then $bx + 2\sqrt{b^2 + x^2} = 14423 = c$ by the question; which equation being reduced and a put = $b^2 - 4$, we have $x = \frac{bc - 2\sqrt{ab^2 + c^2}}{a}$.

* II. *Question 106 answer'd by Mr. John Knipe.*

The bung diam. 32'1152 } inches for { 29'066 } inches for
 The head diam. 23'3168 } ale gall. { 28'103 } wine gall.
 The ullage wine gall. { 32'672 } Ale gall. { 28'018 dry.
 { 65'327 } { 69'981 wet.

The same answer'd by Mr. Rich. Tapper.

Let H = the head diameter, B = bung, D the difference $B - H$. By Mr. Oughtred's theorem $\sqrt{\frac{2BB + HH}{3}} =$ the diameter of an equal cylinder.

But

* II. QUESTION 106.

Putting b and h for the bung and head diameters; by Oughtred's rule $\sqrt{\frac{2b^2 + h^2}{3}} =$ the mean diameter = (by the other method mentioned in the question) $\frac{b-h}{10} \times 7 + b = \frac{7b + 3h}{10}$; from this equation is found $b = \frac{53}{73}h$; that is the bung and head diameters are exactly in proportion as 73 to 53. — Now let $73z$ and $53z$ be the two diameters; then, supposing the content 98 ale gallons, $\frac{2 \times 73z^2 + 53z^2}{1077.157} \times 40.5 = 98$; hence $z = \sqrt{\frac{98 \times 1077.157}{40.5 \times 2.73^2 + 53^2}} = .4399361$, and consequently the two diameters $73z$ and $53z$ are 32'11535 and 23'31662.

Then for the ullage of the cask, it may be truly found by the rule in Cor. 2 page 290 Mensuration. Or, to use the approximating rule given at page 545 of the same, $\frac{17}{32.11535} = .5293555$; the circular segment answering to this quotient is .23785866; then $.23785866 \times \frac{98}{.7854} = 29.68$ gallons = the ullage nearly.

But, $\cdot 7B + \cdot 3H =$ the diameter of the equal cylinder per question; by involution, transposition, and division, we have

$$BB - \frac{126}{53} HB = -\frac{73}{53} HH; \text{ and } HH - \frac{126}{73} HB = -\frac{53}{73} BB. \text{ Hence } B = \frac{73}{53} H; \text{ and } H = \frac{53}{73} B.$$

Wherefore it will be as $53 : 73 :: H : B$, and the contrary, univerfally: and the diameters 21'103 and 29'066 for wine gallons, or 23'316 and 32'115 for ale.

Let $x = \frac{1}{2}$ difference of the wet and dry inches, $b = \frac{1}{2}$ bung diameter. Then $2\sqrt{bb - xx} =$ the breadth of the surface of the liquor in the middle of the cask; and multiplying by x , the fluent will be $2bx - \frac{x^3}{3b} - \frac{x^5}{20b^3} - \frac{x^7}{56b^5} - \frac{5x^9}{576b^7} - \&c. =$ the area of the middle segment of a circle to the radius b , and the chord lines distance from the center in the bung diameter x .

Now to find the length of the radius at any distance from the bung diameter:

Let $a = \frac{1}{2}$ length of the spheroid, $l = \frac{1}{2}$ length of the cask, $b =$ head diameter. Then $aa : bb :: \overline{a+l} \times \overline{a-l} : (aa - ll)$; hence $aabb = aabb - llbb$; put $c = bb - ll$, then $aa = \frac{llbb}{c}$. Let $z =$ the distance of the circle

from the bung diameter whose radius is sought. Then $\frac{llbb}{c}$:

$bb :: \frac{llbb - czz}{c} : \frac{llbb - czz}{ll} =$ the square of the radius;

which rais'd to the $\frac{1}{2}$ power, it will give the radius =

$$b - \frac{czz}{2bll} - \frac{ccz^4}{8b^3l^4} - \frac{ccc z^6}{16b^5l^6} - \frac{5c^4 z^8}{128b^7l^8} - \frac{7c^5 z^{10}}{256b^9l^{10}}$$

&c. which rais'd to its several powers, and substituted in the room of b , it will give the area. The series multiplied by the fluxion of z , gives the solidity or quantity of liquor. Then find the fluent of each term, and let $l = z$, the series will shew $\frac{1}{2}$ of the difference of the wet and dry parts; or, if $l =$ the whole length, gives the $\frac{1}{2}$ difference, which added or subtracted with the contents, shews the quantity of liquor in the cask, 65'5541 vacuity, 32'4458 wine gallons.

* III. *Question 107 answer'd by Sylvia.*

The sum of any whole quantity and the excesses of its greatest part above each of the other, being divided by the number of parts, gives the greatest, and thereby all the other parts. Hence the first had 1361, the second 1339, the third 1288, and fourth 1231 votes.

† IV. *Question 108 answer'd by Mr. A. Naughley.*

Let $b = 65\frac{1}{2}$ perches, $c = 52\cdot16$, $d = 46\cdot98$, $p = 18$; a, e, o, u, y , be several segments of the lines in the triangle. Then $ee - yy = uu$, $aa - dd + 2dy - yy = uu$, $cc - 2ce + ee - oo = pp$, by 47 Euc. 1; $c : e :: b : a$, by 2 Euc. 6; and $o + y : c :: y : e$, by 4 Euc. 6: whence this equation $\frac{bb}{cc} ee - ee + \frac{2de}{c-e} \sqrt{cc - pp + ee - 2ce} = dd = 2077\cdot9612$, which reduced and extracted, gives $e = 28\cdot32$; consequently $a = 35\cdot36$, $o = 15\cdot63$, $y = 18\cdot56$, $u = 21\cdot39$, and the whole base $86\cdot539$.

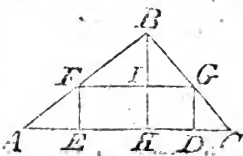
	A.	R.	P.		A.	R.	P.
A's share	1	1	16	C's share	5	1	5
B's ———	3	0	20	D's ———	0	3	21
							V. <i>Question</i>

* III. QUESTION 107.

The rule mentioned in the original solution above, is thus discovered: Let the sum s be divided into n parts, of which the differences between the greatest and each of the rest are a, b, c, d , &c. Then if x be the greatest, $x - a$, $x - b$, $x - c$, $x - d$, &c. will be the others; and their sum $x + x - a + x - b + x - c + x - d$ &c. or $nx - a - b - c - d$ &c. $= s$; hence $nx = s + m$, putting m for the sum of the differences, and $x = \frac{s+m}{n} =$ the greatest; which is the rule.

† IV. QUESTION 108.

The original solution may be explained by this figure, in which $EFGD$ is the rectangle inscribed in the proposed triangle ABC , and BH perpendicular to AC ; then the notation makes $b = AB$, $c = BC$, $d = FG$, and $p = EF$; also $a = FB$, $e = BG$, $o = DC$, $u = BI$, and $y = GI = DH$; and hence the equations and proportions in the solution are evident.



But

* V. *Question 109 answer'd by Mr. Tapper.*

Given $a^{\frac{3}{2}} - a^{\frac{2}{2}} = 4.962a = ba$ to find a . Let $x^6 = a$; then $x^{18} = aaa$, and $x^{12} = aa$, also $x^{\frac{18}{2}} - x^{\frac{12}{2}} = bx^6$, which when contracted is $x^9 - x^4 = bx^6$, and by transposition and division $x^5 - bx^2 = 1$. Here x will be found $= 1.7425615449 +$, and $x^6 = a = 27.9981125 = 27$ years, 364 days, 13 hours and $\frac{1}{2}$ fere, or 28 years *proxime*.

† VI. *Question 110 answer'd by Mr. Nat. Browne.*

The latitude $46^\circ 33'$, the hours 8h. 24 m. and 10h. 15 m.

The

But the solution will be simpler thus : Put b, c, d , and p for AB, BC, FG , and GD respectively, as in the original solution; and $\frac{AB}{BF} = \frac{BC}{BG} = \frac{AC}{FG} = x$: and hence $dx = AC$, and $BG = \frac{c}{x}$.

Then $dx : b + c :: b - c : \frac{bb - cc}{dx} = AH - HC$; hence

$CH = \frac{dx}{2} - \frac{bb - cc}{2dx} = \frac{ddxx - bb + cc}{2dx}$; and then $BH^2 =$

$BC^2 - CH^2 = c^2 - \frac{ddxx - bb + cc}{2dx} = \frac{4b^2c^2 - d^2x^2 - m^2}{4d^2x^2}$,

by putting m^2 for $b^2 + c^2$. Again, $CG : GD :: CB : BH$

$= \frac{px}{x-1}$. Consequently $\frac{4b^2c^2 - d^2x^2 - m^2}{4d^2x^2} = \left(\frac{px}{x-1}\right)^2$;

from which equation x is found $= 1.85$ nearly, and hence the other quantities all become known.

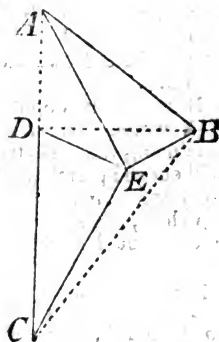
† VI. QUESTION 110.

Here are given two observed altitudes of the sun (supposed to be freed from the errors of refraction), with the (supposed) true interval of time between the observations, as also the declination of the sun; to find the latitude and true times of observation. It is admitted that the watch or time-keeper may be too fast or too slow, but yet however it is supposed to go true for the interval of time between the observations. The declination for the supposed middle true time between the times of observation, may be used for the common declination at both times, unless the interval of time be great; but if this be thought not sufficiently accurate, let the declinations be taken for the two supposed true times themselves, and used in the calculation.

Con-

The Prize Question answer'd.

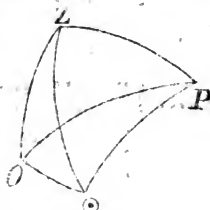
In the first part of the question there is given in a right-angled triangle ABC , the cathetus AB , and the alternate segment of the hypotenuse CD , (made by a perpendicular BD , let fall from the right angle;) to find the other segment DA . Put $c = AB$, $b = CD$, and there will arise this theorem, $a = \sqrt{cc + \frac{1}{4}bb} - \frac{1}{2}b = 4.81903$, and by 47 Euc. 1, the base $= 11.0836$, the perpendicular $DB = 6.55$; which compleats the triangle.



Then

Construction.

On a proper plane, as a primitive, describe the triangle $OP\odot$, making $\odot P$, OP equal to the co-declinations for the two times, and the angle at P equal to the given interval of time; then will P be the pole, and \odot , O the places of the sun at the first and second observations. Again, about the poles \odot , O describe two circles at the distance of the two observed co-altitudes and intersecting in Z the zenith of the place. Then a great circle described through P , Z will be the meridian, the arc PZ = the co-latitude, and the angles $ZP\odot$, ZPO the measures of the times required.

*Calculation.*

Drawing the great circles ZO , $Z\odot$. In the triangle $OP\odot$ are given the two sides OP , $\odot P$ equal the two co-declinations, and the included $\angle OP\odot$ = the interval of time; to find $O\odot$ and the $\angle O\odot P$. Then in the triangle $OZ\odot$, are known the three sides; to find the $\angle O\odot Z$; which taken from the $\angle O\odot P$, there remains the $\angle Z\odot P$. Lastly, in the triangle $Z\odot P$, are known the two sides $Z\odot$, $\odot P$, and included $\angle Z\odot P$; to find the side PZ the latitude, and the $\angle ZP\odot$ the time for the first observation from noon; from which taking the given difference $OP\odot$, there remains the time of the second observation from noon.

Then from *E* where Newbold stands, there is given the angle *AEB* $88^{\circ} 15'$; *BEC* $149^{\circ} 45'$; and *CEA* 122° . To find the distances *EA*, *EB*, *EC*, and *ED*. And here we must note, as in the answer to question 100, that as any two of the angles given, together exceed 180 degrees, the point where Newbold stands will fall within the triangle *ABC*.

Now if you suppose a circle to pass through *C* Eathorpe, *E* Newbold and *B* Tripontium, and bisect the line *CB*, producing that bisection through the center of the circle, it will cut the periphery in a point, from whence lines drawn to *B* and *C*, will compleat a tripezia inscrib'd in a circle; which by 22 Euc. 3, has the two opposite angles taken together equal to two right angles: hence the angle at the periphery will be $30^{\circ} 15'$. In like manner proceed with the 3 points *AEB*, and the angle at the periphery will be $91^{\circ} 45'$.

Then if from the center of the first circle you draw lines to *B* and *C*, the angle contained between them will, by 20 Euc. 3, be double to that at the circumference, viz. $60^{\circ} 30'$, and in the other circle it will be $183^{\circ} 30'$.

But it will be needless to explain the matter any farther, having already, in the last year's diary, given as clear a demonstration as could be, without a large scheme that would admit of all those lines and circles requisite thereto; what remains being purely trigonometrical, from whence I have deduced this followig answer.

		M. F. P.		Tapper.	
		M. F. P.		M. F. P.	
Given {	From High Crofs to Tripontium	<i>AB</i>	8 1 5	8 1 5	
	From Eathorpe to Brinklow	<i>CD</i>	8 7 22	8 7 22	
	To complete the triangle —				
	Brinklow to High Crofs —	<i>DA</i>	4 6 22	4 6 22	
	Tripontium to Eathorpe —	<i>BC</i>	11 0 32	11 0 29	
	Brinklow to Tripontium —	<i>DB</i>	6 4 16	6 4 20	
	Eathorpe to Bennones —	<i>CA</i>	13 6 4	13 6 3	
Newbold to {	High Crofs —	<i>EA</i>	7 4 24	7 4 26	
	Tripontium —	<i>EB</i>	3 2 2	3 2 1	
	Eathorpe —	<i>EC</i>	8 1 16	8 1 11	
	Brinklow —	<i>ED</i>	4 1 16	4 1 20	

Mr. Rich. Tapper answers in the manner following.

Let *a* = the distance of Tripontium and Eathorpe; *c* = the distance of Tripontium and High Crofs = 2605 poles; *n* = the distance of Brinklow from Eathorpe = 2862 poles; then $a = \sqrt{ccnn + \frac{1}{4}n^4} - \frac{1}{2}nn = 3549^{\circ}9'109$ poles; which call *d*. Let *s* = sine of $30^{\circ} 15'$; *m* its cosine, or sine of $149^{\circ} 45'$; *z* = the sine of $88^{\circ} 15'$, *x* its cosine, 1 = radius.

Imagine

Imagine the line which joins Newbold and Tripontium to be extended through the fosse, and a perpendicular let fall from Eathorpe upon it; also a perpendicular from High Crofs upon the said line. Then $d : s :: a : \frac{as}{d}$ = the sine of the angle made by the lines which join Tripontium and Newbold, and Tripontium and Eathorpe, $1 : a :: \frac{as}{d} : as$ = the length of the first perpendicular, $1 : d :: m : ma$ = the distance from Newbold to the place where the said perpendicular cuts the extended line; and $\sqrt{dd - aass - ma}$ = the distance of Newbold from Tripontium, by 47 Euc. I.

Now $\frac{\sqrt{dd - aass}}{d}$ = the cosine of $\frac{as}{d}$. Then, $z : c$

$∴ \frac{\sqrt{dd - aass}}{d} : \frac{c}{zd} \sqrt{dd - aass}$ = the distance from

Newbold to High Crofs; $1 : \frac{as}{d} :: c : \frac{cas}{d}$ = the distance from Tripontium to the place where the perpendicular from High Crofs would cut the line between Newbold and Tripontium, and $1 : c :: \frac{\sqrt{dd - ssa a}}{d} : \frac{c}{d} \sqrt{dd - ssa a}$ =

the perp. also $z : \frac{c}{d} \sqrt{dd - ssa a} :: x : \frac{xc}{dz} \sqrt{dd - ssa a}$ = the distance of the perpendicular from Newbold. Hence this equation, $1 - \frac{xc}{dz} \times \sqrt{dd - ssa a} = ma + \frac{sca}{d}$, which

reduced gives this theorem $a = \frac{d - \frac{cx}{z}}{\sqrt{\left(\frac{cs}{d} + m\right)^2 + s - \frac{sca}{dz}}}$

= 2612.7383 poles.* Q. E. I.

Of

* The PRIZE QUESTION.

This question will be constructed thus :

Construction.

In the first place we have given, in a right-angled triangle, one leg AB , and the alternate segment CD of the hypotenuse made by the perpendicular BD ; and the triangle will be constructed as question 28 page 84. Again, the point E , where the three lines AE , BE , CE make given angles with each other, will be determined as in question 100 page 242.

Of the Eclipses in 1725.

There will be six eclipses this year: Four times will the moon's dark body interpose between the sun and earth, and hide his face; and twice will the earth interpose, and hinder the sun from enlightening the moon: but of these only one of the moon will fall upon our part of the globe.

1. Sun eclipsed, the 2d of April, at 2 in the morning, invifible.

2. Moon eclipsed, the 16th of April, at 9 morning, invifible.

3. Sun eclipsed, 1st of May, at 10 forenoon, invifible.

4. Sun eclipsed, 23th of September, at 7 morning, invifible.

5. Moon eclipsed, on Sunday the 10th day of October, at 7 o'clock in the evening, total and vifible.*

	Begin h. m.	Begin tot. d.	Midd.	End total	End	Dura	Dig.
Astronom. Coventry	V 10	VI 7	VI 56	VII 4	3 42	3 31	21 56
Chartock, London	3 13	6 12	7 4	7 56	3 55	3 41	22 33
Child, Newport	5 28	6 26	7 14	8 3	3 59	3 32	21 36
Turner, Hull	5 15	6 9	6 55	7 41	3 36	3 20	
Leadbetter, London	5 29	6 27	7 13	8 3	3 13	3 32	21 36
Sparrow, Nottingham	5 51	6 46	6 53	7 43	3 41	3 35	22 0

6. Sun eclipsed, 24th of October, at 11 at night, invifible.

New

* This eclipse was observed

1. At *Albano* by *S. Fr. Blanchini*.

h.	m.	s.	
6	45		Total Immersion.
8	20		Emerfion
9	25		The End.

2. At *Bristol* by *Jer. Burroughs, Esq.*

App. Time

h.	m.	s.	
7	31	20	Emerfion or beginning of light.
8	29	30	End.

New Questions.

I. *Question III, by Mr. Rich. Whitehead.*

In some company lately, mathematical fellows,
 By the side of a pond which flow'd hard by an alehouse,
 I began to be pert with my angles and squares,
 With my areas, my bases, my cones, and my spheres;
 (For to talk of old Euclid, you must know I am prone,
 And when out of his elements, am out of my own;)
 When says one that sat next me, hold, prithee a word,
 I'll hold you ten shillings for the good of this board,
 You don't tell me how far cross the water 'tis wide,
 From the place where we stand to that tree on this side,
 And what space does each of these objects divide. }
 From the boat which now lies on the opposite shore,
 With my square and a line (for they'd grant me no more)
 I measur'd in yards, as by figures you see, 147½
 From beyond the said house, strait with it and the tree.
 Then square from this line I immediately went,
 Or a right angle made, the page shews the content, 475
 Till the boat and the tree were exact in one line;
 Then I measur'd five hundred yards seventy and nine, 579
 Quite up to the boat! then I, strait with the house,
 From the tree measur'd yards, as the page fairly shews; 259
 The measure I took square from thence you must note, 507½
 Till I'd brought the said house in a line with the boat:
 Then up to the boat to make matters more clear,
 I measur'd those yards which in margin appear. 674¼
 To finish my working, what made me the quicker,
 Was, I thought I could do't, and make sure of the liquor;
 But my boasted rules fail'd me, nor with all my deep searches
 Could I find out the distance, with its roods and the perches.
 So ladies, I beg, for you're nice at discerning,
 You'd untie this hard knot, which has puzzl'd my learning.

II. *Question III, by Mr. Tho. Dod.*

A wretch who scorn'd to use th' appointed means
 Heav'n's blissful courts to reach, on's own thus leans;
 Who, by mechanic art, a ladder rais'd
 So high, it almost all mankind amaz'd.

Thus Jacob did, says he, and why may'nt I
 Scale heav'n as well as he? at least I'll try.
 Wrapp'd in the clouds his head securely lies,
 And seems environ'd with the azure skies;

A 2

From

From which, 'tis said, a fire-ball falling down,
 Let off a cannon at the base, whose sound
 Approach'd the ear at top in the same time
 The fire-ball fell from ladder so sublime.

Tell me, ye fair, if he-to heav'n was got,
 Or how far soaring from this earthly spot.

III. *Question 113, by Mr. Tho. Grant.*

A father, dying, left three daughters fair,
 To whom he gave five thousand pounds a year,
 On such conditions as did them engage
 To have their shares proportion'd to their age;
 But of their ages all that can be known,
 To effect the purpose is here under shown.

If to each daughter's age when squared you
 Add the rectangle of the other two,

These * numbers will expose themselves to view.
 Now ladies fair, I pray exert your skill,
 And tell them how to satisfy the will.

* 1000, 980, 920.

IV. *Question 114, by Mr. Christ. Mason.*

When mighty Jove this world immense did frame,
 And beauteous form from dark confusion came,
 No sooner he his fiat did display,
 But the crude mass of atoms all obey;
 Each to their center with full speed did haste,
 And dawning light peep'd o'er the gloomy waste:
 Then boundless æther its expansion made,
 And the foundations of the heavens were laid.
 For homogeneous matter was compact,
 And earthly atoms into form did act:
 The humid vapours into seas were made,
 Which did the borders of the earth invade.
 The grosser air around 'em both was spread,
 Like a soft cov'ring to a nuptial bed.
 Plants, fruits, and flow'rs receiv'd their genial birth,
 And sprung with vigour from the pregnant earth.
 Then straight was hush'd the elemental wars,
 And formed thence sun, moon, and twinkling stars;
 Then fish, and fowl, and beasts for food or prey;
 And lastly man the whole for to survey.
 To contemplate and cast his eyes above,
 See with surprize the heav'nly bodies move,

And

And with delight the wand'ring planets trace,
Which thro' the zodiac move from place to place :
Their motions and their magnitudes compare,
And thence conclude how uniform they are ;
How ev'ry one keeps in their proper sphere,
And not, like mankind, strive to interfere.

But ere our thoughts an aerial journey take,
First let 'em here a supposition make ;
That if a ball upon the earth should weigh
Ten pounds in troy, and then cou'd it convey
To th' surface of each planetary sphere ;
I pray unfold what weight it wou'd be there ?

V. *Question 115, by Mr. Bernard Annelly.*

Once on a lofty hill, whence ev'ry where
Around a glorious prospect did appear ;
There many fair and wond'rous works display'd,
Of art and nature exquisitely made :
Amidst the various beauteous objects, I,
From far, a stately fabric did espy,
Rais'd on fair ground, that level stood with me :
Its height, I found, one hundred foot want three.
That time the sun, going down, came in a line
Streight with the house and me ; in height 'twas then
An hour's half quarter ; by which the time did prove
Exact seven hours, and minutes fifty-five.
This on the first of June. Then, ladies, shew
The distance of the building to our view ?

VI. *Question 116, by Mr. John Simmons.*

An oblong close of meadow ground,
That is by water compass'd round :
This by my paces I have found.
That the sum of each side and end,
If to the diagonal be join'd,
Their total makes just half a mile.
I've purchased this close (or isle) ;
And must for it give, by bargain,
For each square yard, a penny farthing ;
But know not what is the whole sum,
Which is the main thing to be known.
There's one I ask'd knew well enough.
An old geodesian gruff,

}

A a 2

That

That lately did the same survey:
 Without large fees, no more he'd say
 Than this, 'Less sides or ends are in extreme
 'Ratio; and the diagonal's the mean
 'Or greater segment, and each side a mean to them.
 'With these hints you may find the answer,
 'I'm very busy—pray be gone, sir.'

Ladies, the sides and purchase pray declare
 In your diary, the next year:
 Nor care a fig for the surveyor.

The Prize Question.

With what vast speed have all improvements run
 Thro' all the ages since the arts begun.
 Euclid's collections, full twenty centuries since,
 Their mathematic knowledge may evince:
 Archimedes the next age did produce,
 Excelling all, was born in Syracuse:
 From him geom'try did much light receive:
 Rise of the globes and spheres to him they give:
 The silver mix'd with gold in Hiero's crown,
 By static art, he made the workman own.
 Said, If he engine-footing had, cou'd move,
 By force of screws, the mighty seat of Jove!
 When Marcellus laid siege to Syracuse,
 The Romans suffer'd, by his engine's use
 In throwing stones; which show red from the sky,
 Like thunderbolts, the Romans to annoy.
 But that great Roman soul strict orders gave
 In storm and plunder, Archimedes to save.
 But, cursed fate! by common soldier's hand
 He's kill'd, whilst poring on his schemes in sand.

What mathematics suffer'd by such blow,
 Ah fruitful brain! still ages want to know.
 By curious theorems, he the distance knew
 'To the enemy, where the stones he threw:
 Who viewing from a corner of the wall,
 Which there run straight, (an acute angle call)
 Along the wall four hundred yards he pac'd,
 Where he the warlike thund'ring engine plac'd:
 Their camp to this line a right angle made;
 Parallel to the wall's ditch, 'tis said,
 Whose length and distance is not known;
 But to our purpose, something hence is shown;
 For at each station, when the camp he spy'd,
 It cut the ditch's ends, as both he try'd.

From

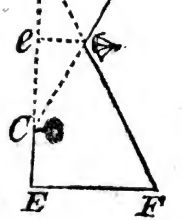
From the first station to the ditch, is found
Two hundred yards, measur'd along the ground.
From the enemy to the ditch's other end,
Two hundred sixty yards our hist'ries send.

Let's know the distance where Marcellus stands,
And a theorem answering our demands?

1726.

Questions answered.

The *III*th Question answer'd by Mr. C. Maſon.



Let

$$\begin{array}{l} 1 \quad BD = b = 147\frac{1}{2} \\ 2 \quad AB = c = 475 \\ 3 \quad AG = d = 579 \\ 4 \quad FG = f = 674\frac{1}{2} \\ 5 \quad EF = g = 507\frac{1}{2} \\ \text{and} \quad 6 \quad CE = h = 259 \\ \text{put} \quad 7 \quad DF = a \end{array}$$

8 E. 6. $a : g :: a - f : \frac{ga - gf}{a} = Ge$

9 $c - \frac{ga - gf}{a} : d :: c : \frac{cda}{ca - ga + gf} = AC$
for $c - g$ put x
 $ccddaa$

9 In. 2 $10 \quad \frac{xxaa + 2xagf + ggff}{ccddaa} - cc = BC^2$

10 - 1 $11 \quad \sqrt{\frac{xxaa + 2xagf + ggff}{ccddaa}} - cc - b = DC$

12 $\sqrt{aa - gg} - b = DC$

13 $\sqrt{\frac{xxaa + 2xagf + ggff}{ccddaa}} - cc - b =$
 $\sqrt{aa - gg} - b$

A a 3

Which

Which equation reduced, and the sums collected, &c. gives $a = 1078.0833$: Then $a - f$ is the distance between house and boat $DG = 403.7499$, and DC the distance between the house and tree $= 692.2499$, and GC between the boat and tree $= 386.$ * *Q.E.I.*

N.B. The letter *G* is omitted at the boat in the preceding figure.

II. Question 112 answer'd by Mr. Sam. Rouse.

Sound moves 1142 feet per second; heavy bodies fall $16\frac{1}{2}$ feet in the first second, according to Dr. Halley. Then put $a = 16\frac{1}{2}$, $b = 1$, $x =$ ladder's height, $d =$ the time found flies $16\frac{1}{2}$ feet; $a : x :: bb : \frac{bbx}{a} =$ square descent of the ball. And $a : x :: d : \frac{dx}{a} =$ the time found moved

* I. QUESTION III.

The final equation will be simpler by substituting x for the unknown perpendicular Ge , the known quantities being as in the original solution: for then, by similar triangles,

$$g - x : g :: f : \frac{fg}{g - x} = DF,$$

$$\text{and } c - x : c :: d : \frac{cd}{c - x} = AC;$$

hence, by right-angled triangles and subtraction,

$$DC = \sqrt{\frac{ccdd}{(c-x)^2} - c^2} - b,$$

$$\text{and } DC = \sqrt{\frac{ffgg}{(g-x)^2} - g^2} - b;$$

$$\therefore \sqrt{\frac{ccdd}{(c-x)^2} - c^2} - b = \sqrt{\frac{ffgg}{(g-x)^2} - g^2} - b.$$

And here if CE or b be supposed equal to BD or b , as those distances are arbitrary, and might as well be measured equal as unequal, then the final equation will become barely

$$\frac{ccdd}{(c-x)^2} - c^2 = \frac{ffgg}{(g-x)^2} - g^2, \text{ in which } x \text{ is easily found.}$$

moved to the ladder's top. Consequently $\frac{dx}{a} = \sqrt{\frac{xbb}{a}}$,
whence $\frac{bbx}{a} = \frac{ddxx}{aa}$, $\therefore x = \frac{bba}{dd} = 81088.085$ feet =
27029.36 yards = 15 miles, 2 furlongs, 34 perches, 7 feet.*

† III. *Question 113 answer'd by Mr. John Turner.*

Let $\begin{cases} aa + eu = b = 1000 \\ ee + au = c = 980 \\ uu + ae = d = 920 \end{cases}$ by the question, then

$$\left. \begin{aligned} &+ 8u^8 - 18du^6 + 2bcu^4 - b^3uu + bbcc \\ &\quad + 18ddu^4 - c^3uu - 2bcd^2 \\ &\quad - bcuu + d^4 \\ &\quad + 5bcduu \\ &\quad - 7ddduu \end{aligned} \right\} = 0.$$

Which being collected and reduced gives the following numbers.

Ages.		Portions.			
		l.	s.	d.	f.
The eldest	23.5276	1784	19	0	$\frac{1}{4}$.7568
Second	22.7788		2	8	$\frac{1}{2}$.3738
Youngest	19.5991		18	2	$\frac{3}{4}$.8694
<i>C. Mason</i> —————		5000	0	0	0

IV. *Quest*

• II. QUESTION 112.

The solution will be a little clearer thus: Putting $a = 16\frac{1}{12}$,
 $c = 1142$, and $x =$ the height. Then $\sqrt{a} : \sqrt{x} :: 1'' : \sqrt{\frac{x}{a}} =$
time of falling x feet; and $c : x :: 1'' : \frac{x}{c} =$ time of sound's
passing over x feet; therefore $\frac{xx}{cc} = \frac{x}{a}$, and $x = \frac{cc}{a} = \frac{1142^2}{16\frac{1}{12}}$
 $= 81088$ feet.

† III. QUESTION 113.

Various methods of solving this question may be seen in Wallis, Kersey, and Ronayne.

* IV. *Question 114 answer'd by Mr. Rich. Whitehead.*

Suppose the sun's parallax 10 seconds, and the magnitude of the earth according to Norwood's observations; then let a = the distance of the earth from the sun, p = the periodical revolution of the earth, s = the periodical revolution of one of 24 satellites. To find its distance from 24 say

$$p^2 : s^2 :: a^3 : \frac{a^3 s^2}{pp} = \text{the cube of the distance sought.}$$

And as the squares of these periods recip. so are the centrip. forces towards their respective central bodies.

Then for the weight of bodies on their surfaces, if the distances are equal, the weight will be as the quantity of matter the bodies contain. If the quantities of matter are equal, the weights will be reciprocally as the squares of the distances: *Ergo*, If neither are equal, the weight will be in a compound ratio. For, as the distance between the sun and earth, and the quantity of matter in the earth, is to ten pounds, so is the distance of Jupiter, and quantity of matter, to the weight ten pounds would weigh on his surface; and so for the rest. Hence ten pound of our troy weight will weigh on the surface of the sun 244 pound, on Jupiter 20, on Saturn 12.75, on the empire of the bedlamites, viz. the moon 3.45.

Mr. Alexander Naughley's answer.

On the surface of the sun 240, 24 19.9, 3 6, 2 5.15,
 2 2.15, 2 2.08, 2 17.

Mr. Tho. Dod computes them from

		☉	24	2	2
Mr. Whiston's numbers	—	245	19.5	13.0	3.2
and Dr. Cheyne's theory	—	79.3	6.4	4.2	5
				V. <i>Quest</i>	

* IV. QUESTION 114.

The proportions of the force of gravity at the surfaces of the planets, or the proportions of the weights of an equal quantity of matter at each, are now stated thus:

Sun	Moon	Mercury	Venus	Earth	Mars	Jupiter	Saturn
25	$\frac{1}{7}$	$\frac{1}{9.5}$	$\frac{4}{3}$	1	$\frac{1}{3}$	2	$1\frac{1}{3}$

These being severally multiplied by 10, we have

250	$3\frac{1}{7}$	$\frac{2}{9.5}$	8	10	$3\frac{1}{3}$	20	$13\frac{1}{3}$
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for the weights required.

V. *Question 115 answer'd by Mr. J. Turner.*

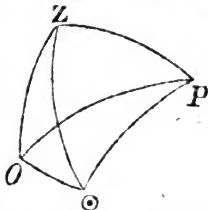
The time was 7 h. 55', and \odot setting in that latitude was 8 h. 2 m. 30 s. The longitude Π $21^{\circ} 50' 17''$. Declination $23^{\circ} 13' 53''$. Ascensional difference $30^{\circ} 37' 30''$. To find the latitude, having the declination and ascensional difference, $\tan.$ declination $23^{\circ} 13'$: radius :: s. ascensional difference $30^{\circ} 37'$: $\tan.$ lat. $49^{\circ} 52' 53''$. Then there are given two sides and an angle included, to find the third side the cosine of the sun's altitude $57^{\circ} 52''$. Then s. \odot altitude : height of the object :: cosine of sun's altitude : length of the shadow 5762.4 feet = 1920 yards.

VI. *Question 116 answer'd by Mr. Whitehead.*

Let a = oblong's greater side, e = lesser, u = diagonal, and $b = 880$ yards = $\frac{1}{2}$ mile, in proceeding several steps you'll have $\sqrt{5} \times u = b - 2a$; put $g = \sqrt{5}$; then completing

* V. QUESTION 115.

The time 8 h. $2\frac{1}{2}$ m. of sun-set is found by adding $7\frac{1}{2}$ min. the half quarter to 7 h. 55 m. the time when the sun is directly behind the top of the edifice; at which time let O denote the sun's place, and \odot the point of sun-set; also let Z be the zenith, and P the pole; and let the great circles be drawn as in the figure.



Then will ZPO be the hour angle of 7 h. 55 m. and $ZP\odot$ the hour angle of 8 h. $2\frac{1}{2}$ min. $P\odot$ or PO the given co-declination, PZ the co-altitude, ZO the co-altitude at the time of observation, and $Z\odot$ the co-altitude at the time of setting, which will be a quadrant, it being the distance between the zenith and horizon.

Wherefore, in the triangle $ZP\odot$ are given $Z\odot$, $P\odot$, and the $\angle ZP\odot$; to find ZP the co-latitude. Then in the triangle ZPO , will be given ZP , PO , and their included $\angle ZPO$; to find ZO the co-altitude at the time of observation. And, lastly, the distance will be equal to the length of the shadow, which is the base of a right-angled plane triangle whose perpendicular is the height of the building, and the angle at the base the sun's altitude; whence appears the reason of the last stating in the original solution.

$$\begin{aligned} \text{pleating the square } aa + ka + \frac{kk}{4} &= \frac{bbg - bb}{14 - 4g} + \\ \frac{bbgg - 2bbg + bb}{49 - 28g + 4gg} &= \frac{45bbg - 10bbgg - 35bb}{880 - 588g + 168gg - 16g^3} = \\ \frac{12098496 \cdot 879012673 +}{32 \cdot 30659103014048} &= 374490 \cdot 04968136201. \end{aligned}$$

$$a + \frac{k}{2} \text{ (i. e. } a + \frac{bg - b}{7 - 2g} = 430 \cdot 299969) = 611 \cdot 9559213549.$$

Hence the greater side of the oblong is $a = 181 \cdot 65595$; e the lesser $= 142 \cdot 80907$; diagonal $= 231 \cdot 06994$. Content $25942 \cdot 1189$ yards at $1d. \frac{1}{4}$ comes to $135l. 2s. 3d. \frac{1}{2} 594$.

The author of this question, in the 4th line, by the words *the sum of each side and end*, design'd to have meant one side and one end: Then the answer would have been 65097 square yards, and purchase $339l. 11d. \frac{1}{4}$; but the expression will much easier mean both sides and both ends, and the answer above truly solves the question.* The

* VI. QUESTION 116.

As the question is worded, the sum of the four sides and the diagonal must be equal to half a mile, and the diagonal a mean proportional between the end or breadth and sum of the diagonal and the said end or breadth.

Wherefore if z = the diagonal, and x = the breadth; then $xz + xx = zz$, and hence $x = z \times \frac{\sqrt{5} - 1}{2}$. Also, by right-angled triangles, the length $= \sqrt{zz - xx} = z \sqrt{1 - \frac{\sqrt{5} - 1}{2}}$
 $= z \sqrt{\frac{\sqrt{5} - 1}{2}}$. So that the breadth, length, and diagonal, are to each other as $\frac{\sqrt{5} - 1}{2}$, $\sqrt{\frac{\sqrt{5} - 1}{2}}$, and 1; and therefore are in continual proportion.

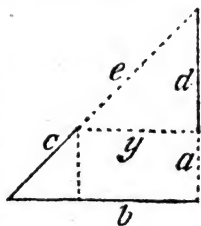
Now the sum of this diagonal with twice the length and breadth is $\sqrt{5} + \sqrt{2\sqrt{5} - 2}$; and then, by proportion, as this sum is to half a mile (the sum given in the question), so is each of the above proportional quantities to the breadth, length, and diagonal of the figure required. Wherefore half a mile or 880 yards drawn

into each of the fractions $\frac{\frac{\sqrt{5} - 1}{2}}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, $\frac{\sqrt{\frac{\sqrt{5} - 1}{2}}}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$,

and $\frac{1}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, will produce the required breadth, length, and diagonal.

The Prize Question answer'd by Mr. Sam. Marriot.

In this right-angled triangle wherein a line is drawn parallel to the base, there is given the base = 400; that segment of the hypotenuse next the base $200 = c$; and the alternate segment of the cathetus $260 = d$. To find the cathetus, &c.



$$d + a : b :: d : \frac{db}{d + a} = y,$$

$$e + c : b :: c : \frac{be}{e + c} = y = \frac{bd}{d + a} \text{ per sim. triangles. Hence}$$

$$bdc + bea = bdc + bed, \text{ or } bdc = bea, \text{ and } \frac{dc}{a} = e. \text{ Again,}$$

$$bb + dd + 2da + aa = \frac{ccaa + 2dc ca + ccdd}{aa} \text{ per 47 E. 1.}$$

$$\text{Hence } \left. \begin{array}{l} a^4 + 2da^3 + bb \\ + dd \\ - cc \end{array} \right\} aa - 2ccda = ccdd.$$

Then $a = 141.73$; $a + d = 401.73$ the distance fought; $c + e$ from first stat. to the camp 566.908 ; y = length of the ditch 258.883 yards.

Mr. R. Tapper answers it thus :

Let a = the distance of the wall from the ditch, $b = 260$ yards, $n = 200$, $m = 400$.

$$1 + \frac{b}{a} + \sqrt{nn - aa} = m. \text{ which reduced will be}$$

$$a^4 + 2ba^3 + bb + mma - 2bnn = bbn.$$

Here a will be found 141.7005 ; $a + b = 401.7005$ the distance of the camp of Marcellus from Syracuse.

The solution of this question may more fully be seen in Ward's Introduction, p. 334.

Of the Eclipses in 1726.

Twice this year will the moon's dark body interpose between the sun and earth, and hide his face; and twice will the earth interpose, and hinder the sun from enlightning the moon: but only two of them will be visible in our part of the globe.

1. Sun eclipsed the 21d of March, about half an hour past 2 o'clock in the afternoon, invisible, by reason of the moon's south latitude, but will be pretty large, and seen about the Straights of Magellan.

2. Moon eclipsed the 3th of April, at 2 in the afternoon, invisible, she being then below our horizon; but in the eastern parts of Tartaria, Mogol, China, &c. it will be above 8 digits eclipsed on the northern limb.

3. Sun eclipsed the 14th of September, a quarter past 5 in the afternoon, visible.*

	Begin.		Midd.		End		Dur.		Dig.
	h.	m.	h.	m.	h.	m.	h.	m.	
Astronom. Car. at Coventry	IV	25	V	17	VI	7	1	42	5 46
Mr. Chattock, Coventry	4	26	5	17	6	17	1	50	6 44
Mr. Chattock, London	4	28	5	25	6	18	1	49	6 46
Mr. Leadbetter, London	4	44	5	37	6	27	1	43	6 3
Mr. Sparrow, Nottingham	4	23	5	12	6	6	1	44	6 1
Mr. Child, Newport	4	44	5	37	6	27	1	43	5 4
Mr. Turner, Hull	4	20	5	14	6	2	1	42	5 29

4. Moon

* This eclipse was observed

1. At Lisbon by F. J. Bapt. Carbone.

				True time.		
				h.	m.	s.
Beginning	—	—	—	3	59	50
Middle	—	—	—	4	58	30
End	—	—	—	5	56	50

The digits eclipsed were $7\frac{3}{4}$.

2. At Ingolstat by the Fathers of the Society of Jesus.

The beginning at 5 h. 17 m. 52 s.

The sun's semi-diameter measured exactly 16' 00".

4. Moon eclipsed on Friday the 30th of September, at 5 o'clock in the morning, visible.*

	Begin.	Midd.	End	Digits
Astronom. Car. at Coventry	III 55	V 4	VI 13	4 45
Mr. Chattock, London	3 26	4 50	6 14	6 36
Mr. Leadbetter, London	3 53	5 3	6 14	4 58
Mr. Turner, Hull	3 34	4 49	6 4	5 28
Mr. Sparrow, Nottingham	2 30	4 55	6 0	5 27

A Letter

* This eclipse was observed

1. At Lisbon by F. J. Bapt. Carbone.

	True time correct.
	h. m. s.
Beginning of the penumbra —	14 37 00
Beginning of the eclipse —	14 57 20
End of the eclipse —	17 33 30
End of the sensible penumbra —	17 54 00

The quantity eclipsed $6\frac{1}{2}$ digits.

2. At Pekin by F. Ignat. Kegler.

	Correct time.
	h. m. s.
Beginnning — — —	12 49 0
Total Immersion — — —	14 46 30
Emersion — — —	15 27 30
The end — — —	16 16 0

The apparent diameter of the moon $32' 30''$.

3. At Padua by S. J. Poleni.

	App time.
	h. m. s.
Sensible penumbra — —	16 16 44
Beginning of the eclipse —	16 21 19

Clouds prevented the observation of the end.

Diary Mathem.

B b

A Letter to the Author.

— 'Tis natural to most part of mankind to despise what they don't understand, and to pass their judgments from appearances: And since your diary is but small, and call'd an almanac, they who are ignorant of the mathematics, are apt to think meanly of that part of it, and conclude your correspondents very fond of having their names in print, if not charge them with enormous pride and downright folly, in having their names put to the questions they propose to answer. I therefore being a party concern'd, could wish that some of your correspondents would vindicate us from such imputations, and set the diary and our performances in a true light. And such persons ought to be told, First, of the extensive uses of mathematical learning, and of the infinite advantages they are to mankind; that the study is not only delightful, but quickens the invention, strengthens the judgment, and enlarges the intellectual faculties. Secondly, that in the diary there has been exhibited a great number of difficult, curious, and useful questions, in all branches of the mathematics, not to be found in any author, with the best methods of solving them, which in any other method probably would never appear to the world. Thirdly, That the diary has incited and led many persons to the study of mathematics, who otherwise perhaps would not have turned their thoughts that way, and has also exercised those who have before studied them so as not to forget what they learnt, and by exciting an emulation whereby they extend their mathematical knowledge. Fourthly, That your correspondents who answer all or most of the questions, must well understand almost all parts of the mathematics, which doubtless is praise enough! That those who answer only some few of the questions must understand arithmetic very well, if they are not acquainted with geometry. So that the least knowing of the answerers are capable of any business wherein the knowledge of arithmetic and some part of geometry are requisite. The solving of some questions does take up much time, and exercises as well the practice as theoretic part of the mathematics. And surely to employ one's leisure hours pleasantly, innocently, and profitably, with inconsiderable charge, is highly commendable; especially since time is generally foolishly and expensively thrown away, &c.

Yours,

*Richard Whitehead.**New*

New Questions.

I. *Question 117, by Mr. Richard Whitehead.*

Having lately the great satisfaction to meet
With some quaint virtuosos, at an elegant treat;
In a bowl of good nectar we drown'd ev'ry care,
And our chat and our liquor did equally share:
How sweet pass'd our time, as we sat round the table,
Measur'd out by the true horological ladle.

The bowl of flint-glass, of particular form,
Where this minute hand did with such ev'ness turn,
As when full, of our mirth it had been the gay source,
Gave, when empty, the rise to a learned discourse;
(For emptiness oft, by the bye, has been found
To occasion deep talk, and discourses profound)
To be short, in the first place they all did agree,
An hyperbolic conoid its inside to be,
Whose abscissa was inches and parts as you see. } 3'98
The line next, the inches and decimals shews,
Which its transverse diameter went to compose. 6'93

The bowl's least diameter they all did opine
Five inches to measure, and parts twenty-nine: 5'29
And they took, pray observe it, its sides which went straight
To be part of the asymptotes; and to give us more light,
Of either of these see the length * shewn below.
This, they said, was all that a person need know,
Its inner diameter right to unfold,
How much it might weigh, and what punch it might hold.
I allow'd what they said, and I told them, with ease,
I cou'd send them an answer to queries like these,
So sanguine I was; yet on setting about it,
After all my great workings, I found myself routed.

So ladies I hope, since I'm put to a shift,
You'll give your most humble admirer a lift.

* $8\frac{7}{8}\frac{2}{3}\frac{7}{8}\frac{6}{8}\frac{0}{8}\frac{0}{8}$

II. *Question 118, by Mr. Christ. Mason.*

Propitious ladies, who are skill'd in arts,
Divide ten thousand into two such parts,
When each of them the other has divided,
Both quotients make just five (if right decided).

B. b. 2.

III. *Quest-*

III. *Question 119, by Mr. John Turner.*

As I was walking out one summer's day,
 To see the verdant fields and meadows gay,
 By chance I did a geodesian spy,
 Who was surveying then a close, hard by,
 Of oval form; but such an odd way he went,
 By which to find its area or content,
 As I before that time, nor since, e'er saw.
 From one o'th' foci to the curve he drew
 Three lines, whose lengths the page doth shew: feet
 The angle between the first and second, 200
 Twenty-five degrees exact was reckon'd; 313.62
 Between the second and third he knew, 872.62
 'Twas threescore and five precisely true.
 From hence the area you may quickly find:
 And one thing more let's know, pray be so kind;
 Quite cros the said ellipse a ditch is made,
 Which cuts the transverse axis, (as he said)
 Two hundred feet from center, as you may
 Suppose, in manner it inclining lay:
 The lesser segment of the ditch I know,
 Is of all lines the shortest you can draw
 From that point i'th' axis to periph'ry;
 What length's each part, ladies, let us see.

IV. *Question 120, by Mr. John Simmons.*

An oval marble fountain's to be made,
 'Midst of a fine partarre, give's your aid,
 To tell the true dimensions, from the shade
 Of the forced water, thro' a jet d'eau;
 Which ten foot at right angles it must throw
 Above the fountain's brim——observe, the sixth o' June
 The shade o' th' top, by the meridian sun,
 Gives half the conjugate;——likewise, at two
 Hours and five minutes after, come and view
 Where the shade must cros the fount's periphery,
 Ten inches short of the shade's length you'll see
 A point, which there does bound the curvity.
 The garden's latitude is known to be 32° 56'
 But if that day the sun shou'd not shine clear,
 Exert your skill, and these four things declare: }
 Transverse, conjugate, and the depth pray tell,
 When sixty wine hogheads can the fountain fill.
 This lin'd with lead all o'er, thus * thick, the weight
 In pounds avoirdupois, inform me right.

* $\frac{3}{4}$ of $\frac{4}{9}$ of an inch.

V. *Quest-*

V. *Question 121, by Mr. Tho. Grant.*

Not far from Cairo, in the Egyptian land,
Amongst their ancient monuments does stand
A small round temple, whose circumference
Is just one hundred yards and seven-tenths.

Its convex front is artfully adorn'd
With hieroglyphics exquisitely form'd.

A spiral tube encircles it around,
Making an angle with the level ground,
Of sixty-one degrees and minutes five,
Till at the temple's top it doth arrive.
From whence, thro' this said tube an iron ball
By its own gravity let freely fall,
Will to the bottom run in seconds eight:
From hence, I pray, declare the temple's height.

VI. *Question 122, by Mr. Sam. Marriot.*

A grandsire to his four grandchildren said,
I have a piece of land was once survey'd;
An oblong form i'th' midst o'th' marsh doth lie,
This formerly was fenc'd about; but I
(Being weary of the charges) threw it ope,
And eat it main with all my neighb'ring folk,
Left nothing standing but a thriving oak
At the east corner; lest I should be fain
In time to come, to fence it out again.

The length, the breadth, the content too of it
Were foolishly upon loose paper writ:
Yet I the same laid by (I thought) with care;
But now I want it, 'tis I know not where.
But this may useful be: I did resolve
Diag'nal wise to hedge this close in half:
A line let fall from th' corner of the close
To the diagonal right angles shows,
Which cut a segment just of chains sixteen
From the diagonal; and if't had been
Prolong'd two chains, would touch the other side;
These two cross lines would this oblong divide
Into four parts, such as I give to you
respectively; and this is all I know.

Now, fair ones, lest they the land should lose,
Pray in your next these four shares expose.

The Prize Question.

Fam'd Eboracum, once Brigantium's height,
 Renowned was by many a worthy wight.
 Four emperors did there receive their birth,
 And three inhum'd, sleep in that hallow'd earth.
 Severus and Constantius there repose,
 And Chlorus too, in peace with all their foes.
 The fourth most fam'd, was the great Constantine,
 Whose name thro' all the christian world did shine;
 Was the first emperor that wou'd embrace
 The christian faith, and baptiz'd at that place.

What still adds luster to renowned York,
 A fabric stands of stately gothic work;
 Whose lofty tow'rs o'erlook the spacious plain,
 And view'd with wonder o'er a vast champaign.
 The weary trav'ler sees the distant place,
 Believes him there, amends his slack'ned pace;
 Pleas'd the refreshing prospect to survey,
 Each stride he lengthens to beguile the way.
 For high in air the lofty turrets rise,
 Peep o'er the distant plains before the dazzled eyes.

As once I travell'd t'ward that ancient place,
 I pry'd to see't, tho' distant many a pace;
 By optic tubes, to help th' defective eye,
 With th' horizon, St. Peter's I did spy:
 When twenty miles I nearer was, did see
 The apex then exalted one degree.
 My eye was just five feet six inches high.
 By what is shewn, the height I pray descry?

Questions

1727.

Questions answer'd.

I. Question 117 answer'd by Mr. Christ. Mafon.

$$cC = b = 9.445$$

$$Ds = c = 2.645$$

$$AD = d = 8.777$$

$$cs = a = ?$$

$$b - a = Cs$$

$$a : c :: b : \frac{bc}{a} = CB$$

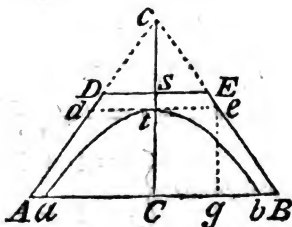
$$b - a : a :: d : \frac{da}{b - a} = Dc$$

$$a : \frac{da}{b - a} :: b : \frac{bd}{b - a} = Ac$$

$$\frac{bbcc}{aa} = CBq$$

$$\frac{bbdd}{bb - 2ba + aa} = Acq$$

$$\frac{bbdd}{bb - 2ba + aa} - bb = CBq = \frac{bbcc}{aa}.$$



Which equation reduced, &c. gives $a = 2.93$, from which all the other dimensions may be easily found. Then *per Archim. de Conoid & Spheroid, Def. 3*, the truncated cone $AdeBba$ will be = a cylinder generated by the parallelogram $Cteg$. Ergo, from the frustum $AdeBA$, take that cylinder, the remainder will be = the solidity of the hyperbolic conoid $atba$; to which cylinder add the frustum $dDEed$, the sum will be equal the solidity of the bowl = 197.873 inches. The solidity of the conoid = 499.774 inches = 2.1635 wine gallons.

Then by { Phil. Transf. } an inch of { 1.54282 } ounces
 { Ward, } glass weighs { 1.493037 } avoird.

And the weight { (1) 305 oz. = 19 lb. 1 oz. }
 of the bowl { (2) 294½ oz. = 18 lb. 7 oz. } avoirdupois.

II. Quesf-

* II. *Question 118 answer'd by Mr. R. Whitehead.*

The two numbers $\left\{ \begin{array}{l} 1726 \cdot 73164 \\ 8273 \cdot 26835 \end{array} \right\}$ added make 4'99999 &c.

† III. *Question 119 answer'd by Mr. W. Gill.*

Dr. Keil, in his *Astro. Lect.* gives a method of determining an ellipse from 3 lines given in length and position, cutting each other in the focus. The

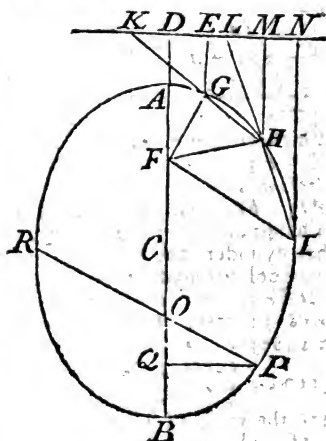
* II. QUESTION 118.

Let x and y denote the two numbers, s their sum; and q the sum of their alternate quotients.—Then $x + y = s$, and $\frac{x}{y} + \frac{y}{x} = q$: Hence $xx + yy = qxy$, and $xx + 2xy + yy = ss$; or, by substitution, $qxy + 2xy = ss$; therefore $4xy = \frac{4ss}{q+2}$; and; by subtraction, $xx - 2xy + yy = ss - \frac{4ss}{q+2} = \frac{q-2}{q+2} \times ss$; therefore $x - y = s\sqrt{\frac{q-2}{q+2}}$.

Consequently $\begin{cases} x = \frac{1}{2}s + \frac{1}{2}s\sqrt{\frac{q-2}{q+2}}, \\ y = \frac{1}{2}s - \frac{1}{2}s\sqrt{\frac{q-2}{q+2}}. \end{cases}$

† III. QUESTION 119.

It is demonstrated, by the writers on conics, that if C be the center and F the focus of an ellipse, and in the transverse axe BA produced there be taken CD a third proportional to CF and CA , and from any point G in the curve GE be drawn parallel to BD and meeting DE perpendicular to it in E , and FG be drawn; then FG will always be to GE , in the constant ratio of CF to CA .—Wherefore, if G, H, I be the three given points, or ends of the given lines FG, FH, FI , drawn from the focus F ; and there be drawn HG, IH , and produced to K and L so that HK be to GK as FH to FG , and IL to HL as FI



to

The transverse diameter 1000 feet, conjugate 600, the content of the field 10 a. 3 r. 10 perches, the angle of inclination of the transverse $64^{\circ} 21'$. From the doctrine of fluxions, if the lesser segment be suppos'd to be the hypothenuse of a right-angled triangle, also a minimum, and a perpendicular let fall upon the transverse diameter. The base of the said triangle will be a fourth proportional to the transverse, the latus rectum, and the distance of the perpendicular from the center of the ellipsis, that is $1000 : 360 :: 200 + x : x = 112.5$. Hence the lesser part of the ditch = 259.8 , greater = 330.66 , and the whole length = 590.46 .

IV. *Quæf-*

to FH ; and then if KL be drawn, and perpendicular to it IN , HM , GE , FD ; and lastly FD be divided in A in the given ratio of FG to GE ; then A will be the end of the transverse, and the whole of the ellipse is thence determined.—For, KH being to KG as FH to FG by the construction, and KH to KG as MH to EG by similar triangles, therefore FH will be to FG as MH to EG , or FH to HM as FG to GE ; and in the same manner $FI : IN :: FH : HM$; wherefore in general $FI : IN :: FH : HM :: FG : GE ::$ (by the above cited property) $CF : CA$; whence the center C and the whole ellipse becomes known.

Again, for the shortest line OP that can be drawn from the given point O in the axe to the curve; since it must evidently be perpendicular to the curve or to the tangent in the point P , it may be determined from that consideration alone and the property of the curve, independent of fluxions; and from thence will easily arise the property of it mentioned in the original solution, and as is actually determined at *prop. 10 lib. 5 Apol. Con. viz.* $AB : \text{latus rect.} : CQ : OQ$; hence the point Q is found, and of consequence OQ ; and then OR as in question 103 page 246.

* IV. *Question 120 answer'd by Mr. Mafon.*

Given the lat. —	52° 56'	As sine of the altitude	52° 11"
Its complement —	37 4	Is to the height	120 inches
Sun's declination add	23 25	So cosine altitude —	37° 49"
Sun's merid. altitude	60 29	To length of shadow	93° 155 in.
As s. sun's altitude	60 29	From which subtract	10 inch.
To the height obj. —	120 in.	Remainder	83° 155.
So is cos. sun's alt.	29° 31'	As cosine sun's altitude	37° 49"
To length shadow —	67° 989	To sine time past noon	31 15
As radius		So cosine ☉'s declin.	66 34
To cos. time from noon	58° 45'	To sine sun's azimuth	50 55
So is cos. lat. —	52 56	As radius — —	90 0
To tang. of a 4th arch	32 51	Is to — —	83° 155
Which sub. fr. ☉'s dist. of pole		So cosine azimuth —	50° 55"
leaves a 5th arc =	33° 44'	To the ordinate <i>ea</i> =	52.4.
Cosine 4th arch —	57 09	As radius	
To cosine 5th arch —	56 16	To — — —	83° 155
So sine of the lat. —	52 56	So sine — —	50° 55"
To sine of the altitude	52 11	To <i>de</i> — —	64.53

Let

* IV. QUESTION 120.

The spherical calculations, in the original solution above, will be evident by applying the given declination, latitude, and hour to the spheric triangle in page 127; for if ZP represent the co-latitude, $P\odot$ the co-declination, and their included angle P the hour from noon, all which are given; then $Z\odot$ will be the co-altitude, and the $\angle Z$ the azimuth, both which are hence easily found.

Again, for the ellipse, instead of the jet d'eau suppose a pole of 10 feet high erected in the center d of the ellipse; then will the shadow of it at noon be the semi-conjugate axe dc , and 10 inches less than the shadow of it when the azimuth is equal to the $\angle adc$ will be the semi-diameter $db = da$. Which are easily determined as in the original solution.

Every thing else in the original solution is very well determined except the transverse axe, which may be better found thus, by the common property of the ellipse, as $\sqrt{dC^2 - ac^2} : dc :: dC : dT$ the semi-transverse.

Let $ea = b = 52.4$

$dC = c = 67.989$

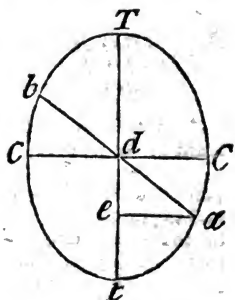
$de = d = 64.53$

And $et = a$. *Quære a?*

$dd + 2da + aa : cc :: da$

$$: \frac{ccda}{dd + 2da + aa} = bb.$$

Reduced, $bbaa + 2bbda - ccda = bbdd$. In numbers produces $a = 36.86$. Then $1 : .7854 :: Tt \times cG : 21640.4668$ inches = the area, by which divide the given content, gives the depth 40.35 inches. Add twice the thickness of the lead to each diameter, and once to the depth: from which elliptical cylinder subtract the given content, gives the inches of lead 11614 , which according to Ward's specific gravity of lead, is equal to 76116 ounces avoirdupois = 2 tun, 2 hund, 1 quar. $25\frac{1}{4}$ lb. weight.*



* V. *Question 121 answer'd by Mr. Whitehead.*

The proposer has either unlimited or unhing'd the question, by giving the circumference of the tower incoherent with the time; either alone would have limited it.

According to Gallilæus, and experiments made by several ingenious artists of late, as

$1 : 16\frac{1}{2} :: 8'' \times 8'' = 64 : 1029\frac{1}{2}$ = the space a body will describe a perpendicular descent in $8''$ of time. Then

As the sine of given angle $ACB = 61^\circ 5'$

Is to the side — — $AB = 1029\frac{1}{2}$

So is the radius

To the hypotenuse $AC = 1175.81$

Then let fall the perpendicular aB , and while a body accelerates the space AB , another will describe the space Aa , along the inclin'd plain AC , as has been demonstrated by the illustrious Sir Isaac Newton. Having

found the segment $Aa = \frac{AB^2}{AC} = 901$, &c.

Say, as radius : $Aa = 901$, the length of the tube :: s. of the given angle $Aab = 61^\circ 5'$: $Ab = 788.72$ feet, — the height required.



Mr.

Mr. Grant's solution to the 121st question, taken from the Diary for 1729, and who thinks Mr. Whitehead's solution was not right.

As $1 : 193 : 64 :: 12352$ inches = the perpendicular descent of the body by gravity in 8" of time: Then as the radius : sine of $61^{\circ} 5'$:: $12352 : 10812$ inches = the space described in 8" by a body descending along a plain that makes an angle of $61^{\circ} 5'$ with the horizon, which would be the tube's length were it a right line, but being a spiral to the temple which the question supposes a cylinder whose periphery is 100.7 yards; it is evident, that as the ball descends it will also by the tube's curvature be carried in the said periphery, therefore it will be acted on by a *vis centralis*, in a direction parallel to the horizon, which will not forward the ball's descent, but will constantly diminish it, and consequently the velocity that would arise therefrom, which will occasion the ratio of the spaces described by the ball descending in the tube, to the times of their description to be always variable. Wherefore I compare in a ratio, as the semi-ordinate of a conic parabola to their respective abscissas, whence the following analysis: where x = tube's length the ball runs in 8".

Radius : cof. $61^{\circ} 5'$:: $x : .483537x$ = to an arch described in 8", in the periphery, which squar'd, divided by the diameter, gives $.0002026167xx$ = the space in 8", agitated only by the central force; which multiply by x^2 , and make it the abscissa of a parabola convex to its axis, x its ordinate, and the parameter will come out = 4935.427 in. = a , the parabol. curve, by compounding the motions along the ordinate and abscissa, will be = 10812 inches = the space in 8", by a body descending along the inclin'd plain. Then, by the doctrine of fluxions, $x = 6175$ inches = $514\frac{7}{8}$ feet the tube's length, and radius : s. $61^{\circ} 5'$:: $6175 : 5405$ inches = 450 feet, the temple's height.*

VI. *Quest-*

† V. QUESTION 121.

After all Mr. Grant's labour and time spent in the solution of this question, Mr. Whitehead's solution is right. For the side of the tube, by impelling the ball in the horizontal direction, does not alter its perpendicular velocity or descent; and therefore the spiral may be considered as a straight inclined plane in the solution.

Of the Eclipses in 1727.

Twice this year will the moon's dark body interpose between the sun and our part of the earth, and hide part of his face from our light. But only one will be visible.

1. Sun eclipsed, on Saturday the 11th day of March, at 8 at night, but not visible to us by reason the sun is then set.*

2. Sun eclipsed, on Monday the 4th of September, at 7 in the morning, about 2 digits, invisible. The calculation by Street's Caroline Tables, for the meridian of the city of Coventry.†

The beginning at Coventry	—	—	VI	31
The middle or greatest observation	—	—	VII	3
The end	—	—	VII	35
The whole duration	—	—	I	5
Digits eclipsed south	—	—	I	56 58

New

* This eclipse was observed

At Vera Cruz by Mr. J. Harris.

				App. time
				h. m.
The beginning	—	—	—	0 49½
Middle as near as could be judged	—	—	—	2 30
End about the N. N. E. part of his disk	—	—	—	3 59½

† This eclipse was observed thus :

At	By	Beginning	End Ant. Merid.
		h. m. s.	h. m. s.
Lisbon	F. J. Carbone	— — —	7 9 2 true time
Padua	J. Polenus	— — —	8 38 42 true time
Rome	J. D. Maraldi	— — —	8 44 10 true time
Bologna	E. Manfredi	— — —	8 36 6
Wirtemberg	J. F. Weidlerus	7 18 19	8 29 51

New Questions.

I. *Question 123, by Mr. Rich. Whitehead.*

As a Philomath Cato, with attention profound,
 Was preparing a map of some neighbouring ground;
 And to objects remote was directing his eye,
 With his body half bent, 'twas my chance to come by:
 We fell into talk (for you must know for some years
 I've been a small trader in angles and squares);
 He told me what methods he took, and what ways,
 To determine the distance of this from that place.
 Says I, you go wrong, friend, or at least round about,
 To arrive at this thing, there's a much nearer route.
 On this, Euclid's son, with a sneer, made a motion,
 That I'd practise what he thought was only a notion.
 What I said I cou'd no ways refuse to make good,
 And the case that he chose for my trial thus stood:
 Three towns there were lying (to prevent any blunder,
 Call *B*, *C*, and *D*) many paces asunder;
 The distance of each one of these from a town
 That was placed within them, call'd *L*, was well known,
 It being in miles and in yards as below is shown. }
 From the towers of the two first-named places I took
 The angles from one to another; pray look
 At the bottom*, for there their true measures appear:
 But from none of those tow'rs, if I look'd a whole year,
 Cou'd I've seen the town *L*, it was plac'd down so low;
 For want of which height I was forc'd to let go
 My design, which I boasted I'd soon bring to pass,
 And desist from my work with no very good grace.
 So, ladies, I hope, for this once, you'll descend,
 To assist a poor well-wishing batchelor friend:
 For the future, no more such vain toils I'll pursue,
 And leave off surveying—unless 'tis of you!

* The angle $B = 65^{\circ} 10' .96766$; $C = 77^{\circ} 0' .07237$; $D = 37^{\circ} 49'$.

The lines $\begin{Bmatrix} BL & 7 \\ CL & 6 \\ DL & 4 \end{Bmatrix}$ miles $\begin{Bmatrix} 528 \\ 880 \\ 704 \end{Bmatrix}$ yards.

II. *Question 124, by Philosophicus.*

Strephon unfortunate ! by cruel fate,
 He's quite bereav'd of his most happy state.
 Celia, whom he dearly did adore,
 Bright object of his amorous desire,
 She's lost, unheard of by some ill adventure.
 He's oppress'd with utmost grief for his great loss,
 In sighs and tears he wails his wretched case:
 No pains he spares, the fair to have again,
 But O, she's gone ! his search proves all in vain:
 Yet, fill'd with fierce desires, he will pursue
 A search incessant, still her fate to know.
 Ev'n thro' all parts o'th' spacious world he'll rove,
 Nothing shall him deter, so inspir'd by love.

After a long and tedious course of travel,
 Having lasted all its great fatigue and toil,
 He to a distant country then is thrown,
 A place fam'd for an oracle divine.
 Now, cries the joyful youth, my hopes revive !
 This sage diviner may some tidings give.
 Then straight he hasten'd to the sacred place,
 Where stood the oracle, and there his case
 Before him laid ; then earnest did invoke
 His pow'r : when thus the sacred statue spoke :
 This place is in the latitude of forty-eight,
 If hence on this meridian thou mov'st straight
 With equal motion, tow'rd's the great equator,
 And pass precise o'er fourteen miles each hour,
 Accounting still the motion that was given
 Thee, by the earth's diurnal revolution :
 When by this compound motion thou hast gone
 The space of fifteen hundred leagues and one,
 There end thy journey ; for thou would'st b' arriv'd
 Unto the place where doth the fair reside.

Now, ladies, your bright wit must this explain ;
 And tell what latitude the nymph was in.

III. *Question 125, by Mr. John Turner.*

Within the northern arctic circle stand
 Three hills, which o'er the circumjacent land
 Raise their aspiring top, in ice involv'd,
 And snow by Phœbus' rays not yet dissolv'd,
 A land-mark well unto the seamen known,
 When driv'n by storms and tempests up and down,
 I'th'

I'th' spacious depth; far distant they appear,
 With heads envelop'd in the atmosphere;
 More fam'd than Teneriff, or Andes hill.
 The height of *A*, for so the first I call,
 In poles is thirty-two; the second *L*,
 Twice forty-eight, not more; the third, or *C*,
 Its altitude exactly fifty-three.
 And from the base of *A* to *L* is found,
 Two hundred poles measur'd upon the ground.
 Now't happens on a certain day i'th' year,
 (But which I leave to you for to declare)
 That th' utmost limits of the top of *A*
 Its shade shall transfit thro' the foot of *C*;
L's shade thro' *A* and *C* will take its way,
 And that of *C* thro' *A* alternately.
 From hence pray tell what's the sun's declination,
 And also what the pole's true elevation,
 Where these phænomena will true appear,
 And you'll oblige your humble serviteur.

IV. *Question 126, by Mr. Tho. Dod.*

'Tis to you, lovely ladies, I sue and submit,
 (Who out-vie Sidrophel in magic and wit)
 For solution of this knotty problem propos'd,
 By which undertaking my senses are doz'd:
 To find by what canon the squares you do fill
 Which are magical call'd, and by that try your skill;
 To place all these numbers * so that the amount
 Just half a score ways seventy-four you may count:
 If you'll answer but this, now yourself do assure,
 I will meddle with what they call magic no more.

* 8, 9, 10, 11, 14, 15, 16, 17, 20, 21, 22, 23, 26, 27, 28, 29.

V. *Question 127, by Mr. Tho. Williams.*

Our modern nat'ralists dispute—Whence came
 The water that destroy'd the earth's first frame?
 Some bring it from the moon; and some have thought
 That from above the firmament 'twas brought:
 Others—that 'twas created for that end,
 Or from a deep abyfs did then ascend.
 The last the sacred writ doth intimate,
 As Woodward has explain'd it to's of late:
 The which abyfs (with Halley) he wou'd have
 Concentric with the earth, an orb concave.

The Prize Question.

In fam'd Sicilia's isle a garden lies,
From storms defended, and inclement skies:
Fenc'd with a green inclosure all around,
Tall thriving trees confess the fertile ground.
A sylvan scene in solemn state display'd,
Flutters each feather'd warbler with a shade:
The gentle spirit of the western gale
Eternal breathes on fruits untaught to fail;
The ruling orbs no wint'ry horrors bring,
Fixed in th' indulgence of perpetual spring:
Here spices in parteres promiscuous blow,
Not from Arabia's field more odours flow:
The order'd vines in equal ranks appear,
And verdant olives flourish round the year;
Here grapes discolour'd on the sunny side,
And there in autumn's richest purple dy'd;
Beds of all various herbs, for ever green,
In beauteous order terminate the scene.
Sev'n chrystal streams, from sev'n fair fountains flowing,
The lovely landscape grace with soft murmurs,
In wild meanders slowly run, as seeming
Unwilling to forsake the pleasing soil.
I'th' midst of a grass-plot, form'd with artful care,
Its radius fifty feet, being circular,
Two rectilinear walks from the center flow,
Making an angle as express'd below: 55 deg.
The length of *A*, from thence twice fifty-four,
Of *B* just eighty feet, nor less, nor more;
From whose extremities two lines must be
Drawn back to the circle's periphery,
Where (meeting) they must equal angles form,
On each side, with a tangent to be drawn
To the said point of concurrence: Now what are
The lengths of these two lines, I pray declare?

1728.

Questions answer'd.

I. Question 123 answer'd by the proposer's method.

Put $a = BD$, $b = LB$, $d = DL$, $c = CL$, $m = \text{fine } \angle CDB = 6131'369$, $n = \text{fine } \angle PCD = 7899'767$, $r = \text{radius} = 10000$, $s = \text{fine } \angle BCD = 9743'748329$, $t = \text{fine } \angle CBD = 9076'46563$.

By trigonometry,

$$\frac{ta}{s} = CD, \frac{mta}{rs} = CP, \text{ and } \frac{nta}{rs} = PD.$$

By oblique triangles,

$$\frac{aa + dd - bb}{2a} = KD, \frac{ttaa + sscc - ssdd}{2sta} = CE, \text{ and } \frac{ttaa + ssdd - sscc}{2sta} = ED.$$

By similar triangles,

$$PD : PC :: KD : KG = \frac{maa + mdd - mbb}{2na},$$

$$PD : DC :: KD : DG = \frac{raa + rdd - rbb}{2na},$$

$$CD : CP :: GK : GH = \frac{mmaa + mmdd - mmbb}{2rna},$$

$$CD : DP :: KD : DH = \frac{naa + ndd - nbb}{2ra};$$

hence $GD - ED = GE =$

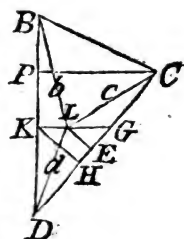
$$\frac{rstaa + rstdd - rstbb - nttaa - nssdd + nscc}{2nsta},$$

Then by similar triangles,

$$CP : PD :: GE : EL = rstaa + \&c. \text{ divided by } 2msta,$$

$$\text{or } EL = \frac{21538697327713058aa - 11'839151262}{a} = \frac{qaa - p}{a};$$

also



$$\text{also } CE = \frac{465758419083091733aa + 12'28641236}{a} = \frac{kaa + l}{a}$$

therefore $LE^2 + CE^2 = LC^2$;

$$\text{that is, } \frac{qqa^4 - 2qpaa + pp + kka^4 + klaa + ll}{aa} = cc,$$

$$\text{or } 2pqaa + ccaa - 2klaa - qqa^4 - kka^4 = ll + pp;$$

that is, by division and substitution, $xaa - a^4 = z$,

or $xe - ee = z$, by putting $e = aa$;

$$\text{hence } e = aa = \frac{x}{2} + \sqrt{\frac{xx}{4} - z} = 127'6958908986685,$$

and $a = 11'300260066 = BD$, and the rest

$$\left. \begin{array}{l} CD = 10'526383 \\ CB = 7'1108241 \end{array} \right\} \text{ miles} = \left\{ \begin{array}{l} 11 \text{ m. } 2 \text{ f. } 16 \text{ p.} \\ 10 \quad 4 \quad 8 \\ 7 \quad 0 \quad 35 \end{array} \right.$$

Mr. *John Turner* has very curiously wrought this answer by trigonometry, and an algebraical process to this biquadratic adfected equation,

$$\begin{array}{r} -4cc \\ 1 + g^2 x^4 + 2dxx = -dd \\ + 2gb \end{array}$$

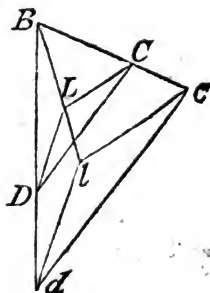
$$x = \sqrt{ss - t + s} = 11'2983 \text{ miles, } 10'525, \text{ and } 7'11.$$

II. *Quef.*

* I. QUESTION 123.

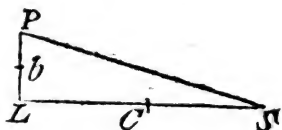
Describe the triangle Bcd similar to the proposed one, or whose angles shall be equal to the given ones: then, by prob. 31 Simpson's Geometry, determine the point l such, that the three lines Bl, cl, dl may be in proportion to each other as the three given distances BL, CL, DL : upon Bl take $BL =$ the given distance of B from L ; and draw LD, LC parallel to ld, lc ; and join D, C : so shall B, C, D, L be the four points required.

Which is too evident to need a formal demonstration.



II. *Question 124 answer'd by Mr. Turner*

Let $SP = 4503$ miles $= d$,
 $b = 14$, and $c = 1039$ the
 number of miles which every
 point of the equator is carried
 through in the space of
 an hour, by the earth's diurnal
 revolution; then the ratio
 of PL to SL , will be ba to ca : But $b^2 a^2 + c^2 a^2 = d^2$
 Euc. 47. 1. Hence $a = \sqrt{\frac{dd}{cc + bb}}$, consequently $PL =$
 $ba = 60.676$ miles, the difference of latitude, and the lati-
 tude arriv'd in will be $46^\circ 59' \frac{1}{4}$ north.



This may likewise be solv'd trigonometrically, and has
 some affinity to current sailing, the motion of the earth re-
 presenting the current's motion, the man being carried by
 the compound motion from P to S : but each point of the
 parallel of 48° does not run through 1039 miles per hour,
 and the line PS will indeed be a spiral line upon the globe.

Mr. *Geo. Brown* has well answered and demonstrated this
 question, and found the latitude to be $46^\circ 16'$: but the
 operation and scheme my room will not admit.*

III. *Quest-*

* II. QUESTION 124.

The original solution to this question is not right, because the
 motion in the parallel is made constantly equal to that at the
 equator; whereas the intent of the question seems to be, to find
 the spiral described on the globe by a point, which is urged with
 a given constant velocity in the direction of the meridian, and a
 given constant angular velocity around the pole in the direction
 perpendicular to the meridian; the rates being 14 miles on the
 meridian to the 24th part of the parallel of latitude.—Or it may
 be conceived by supposing a point to move along the brass meri-
 dian of a globe, at the rate of 14 miles while the globe turns round
 15 degrees, the motion answering to an hour; for then the parts
 of the globe passing directly under the point, will trace out the
 spiral.

Wherefore, if x be put for the cosine of the variable latitude,
 and consequently $\sqrt{1 - xx}$ its sine to the radius 1; also $a =$
 14 miles, and $b = 1.15$ th part of the equator: since $bx =$ the
 motion per hour in the parallel of latitude, and $\frac{x}{\sqrt{1 - xx}} =$
 the

* III. Question 125 answer'd by Mr. Brown.

There's a demonstration of this in Sir Isaac Newton's Universal Arithmetic, too large to insert, by which I make the latitude $81^{\circ} 30'$, and sun's declination $17^{\circ} 22'$.

Mr. *Mason*, Mr. *Whitehead*, and some others say this question is unlimited, or at least admits of more true answers than one: but having received none but the above, I shall not here give my judgment till further trial be made at a more leisure time, except Mr. *Bent*'s latitude $80^{\circ} 45'$, declination $19^{\circ} 27'$.

IV. Quesf-

the fluxion of the arch of the meridian or abscissa of the spiral,

we shall have as $a : bx :: \frac{x}{\sqrt{1-xx}} : \frac{bxx}{a\sqrt{1-xx}} =$ the

fluxion of the parallel or ordinate of the spiral; then the sum of the squares of these fluxions of the ordinate and abscissa will be equal to the square of the fluxion of the curve of the spiral, or

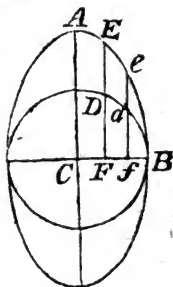
fluxion of the spiral $\dot{z} = \dot{x} \sqrt{\frac{aa + bbbx}{aa - aaxx}}$, or $= \dot{x} \sqrt{\frac{1 + qxx}{1 - xx}}$

by putting q for $\frac{bb}{aa}$. Now, by Cor. 2 pa. 228 Mensuration, it

will be found that this expression is the fluxion of an elliptic arc whose semi-axes are 1 and $\sqrt{\frac{aa + bb}{aa}}$. Wherefore if the circle

whose radius is 1 be circumscribed by the ellipse whose transverse semi-axe AC is $= \sqrt{\frac{aa + bb}{aa}}$, and BD be the degrees or

arc of the latitude, and EDF be drawn parallel to AC ; then CF will be $= x$, and the arc $AE = z$ the above fluent, or length of the spiral from the pole: Also Ee will be the length of the spiral between any two latitudes BD, Bd . So that if BD be the given latitude of 48° , and DE be drawn parallel to AC ; then take $Ee = 45^{\circ} 3$ miles the proposed length of the spiral, and draw ed parallel to ED ; so shall Bd be the latitude required.



* III. QUESTION 125.

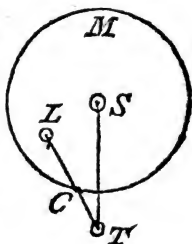
This question has evidently been made from prob. 55 of Sir Isaac Newton's Arithmetic, where a full solution may be seen.

* VI. *Question 128 answer'd by Mr. T. Williams.*

The common center of gravity of the earth and moon goes through the magnis orbis so, that the areas described by the radii to the fun are proportional to the times; the accelerating gravities are as the quantities of matter in those bodies; the mass of the earth is given equal to 39008956283823202513476 cubic feet; the diameter of the \textcircled{D} to the diameter of the $\textcircled{\ominus}$, as her apparent semi-diameter to her horizontal parallax. Hence her magnitude 801682492916446916225 feet: The attractive force will be the same in respect to their distance from the common center of gravity, as in respect of the whole distance between them.

Let S denote the sun, MC the magnus orbis describ'd by the common center of gravity of the earth T , and the moon L , C the \textcircled{D} in octant, her mean distance $60\frac{2}{3}$, semi-diameter = 1309095060 feet = TL . Now as the \textcircled{D} and $\textcircled{\ominus}$ tend to C as to one another, $CT : CL ::$ mass in L : mass in T .

Therefore $CT = 26361759$ feet = 4083 miles, and $CL = 1282733200$ feet = 242752 miles.



Mr. *Mason*, the proposer, answers thus: d = mean diameter = 268923 miles, q = the quantity of matter in the earth, and $r = \textcircled{D}$, a = distance of the common centers from the sun; $q : r ::$ mass $\textcircled{\ominus}$: mass \textcircled{D} , $qa = d - a$ per statics, and $qa + a = d$; hence $a = \frac{d}{q + r} = 5899'34$ miles.

Mr.

* VI. QUESTION 128.

If e be the quantity of matter in the earth, and m that in the moon, or any other two bodies, and d their distance afunder. Then, per statics, as $e + m : d$

$\therefore \left\{ \begin{array}{l} m : \frac{dm}{e+m} = \text{the distance of the earth} \\ e : \frac{de}{e+m} = \text{the distance of the moon} \end{array} \right\}$ from the common center of gravity.

Diary Mathem.

D d

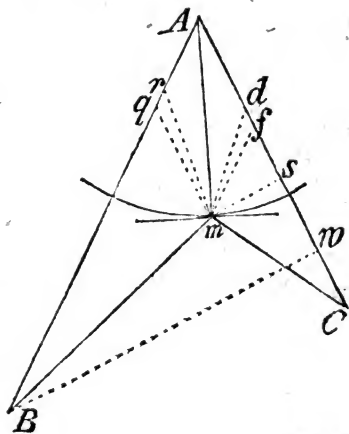
Mr. Turner has curiously explain'd this, and says the author ought to have told whether in 6 or 8, &c. but that nothing certain can be laid down, since we cannot truly determine the distance and magnitude of the sun; and that regard should be had to their densities, and specific gravities, &c.

* VII. Question 129, answer'd by Mr. Da. Nairne.

The pendulum vibrates 1000 per hour = $16\frac{2}{3}$ per minute, and one of 39.2 inches vibrates 60 per minute; also they being in a duplicate ratio of their vibrations, therefore the length of the candlestick will be found 508 inches; and the candlestick above the floor 314. Hence the whole height = 822 inches = 68.5 feet.

The Prize Question answer'd.

Join AB , AC and Am ; draw ms and Bw $\perp AC$, $mq \parallel AC$, $mf \parallel AB$; draw md so that $\angle mda = \angle amc = amB$, and mr that $\angle arm = amB$. Then the triangles amb , amr are similar, as also amC and amd : also the triangles rmq , dmf are similar. Then let $a = 108 = AB$, $b = 80 = AC$, $c = 61.95 = Aw$, $d = 88.47 = Bw$, and $r = 50 = Am$; also $x = As$, $y = ms$. Then $mf = \frac{ay}{d}$, and $Sf = \frac{cy}{d}$,



which

* VII. QUESTION 129.

As $1000^2 : 3600^2$ or as $10^2 : 36^2 :: 39.2 : 39.2 \times 3.6^2 = 508$ inches the length of the cord or line.

Again, if x = the whole height, and $a = 508$ = the greater part. Then $x : a :: d : x - a$; hence $xx - ax = aa$, and

$$x = \frac{1 + \sqrt{5}}{2} \times a = 821.96 \text{ inches} = 68\frac{1}{2} \text{ feet nearly.}$$

which taken from x , we have $Af = x - \frac{cy}{d} = mq$, and $Aq = mf = \frac{ay}{d}$. Again, in the like triangles, Amb , Amr , $Ar = \frac{rr}{a}$; and in AmC , Adm , $Ad = \frac{rr}{b}$, which taken from $Af = x - \frac{cy}{d}$, we have $df = x - \frac{cy}{d} - \frac{rr}{b}$. Also $rq = \frac{ay}{d} - \frac{rr}{a}$. Then $mq : qr :: mf : df$, that is $x - \frac{cy}{d} : \frac{ay}{d} - \frac{rr}{a} :: \frac{ay}{d} : x - \frac{cy}{d} - \frac{rr}{b}$; and, crossing extremes and means, $xx - \frac{2cyx}{d} - \frac{rrx}{b} + \frac{ccyy}{dd} + \frac{rrcy}{db} = \frac{aayy}{dd} - \frac{rry}{d}$; or for $aa - cc$ put dd , and transpos'd $\frac{ccyy}{dd}$, &c. comes $x^2 - \frac{2cyx}{d} + \frac{rrx}{d} - \frac{rrx}{b} = yy - \frac{rrcy}{db} - \frac{rry}{d}$. Proceeding finds $x = 45.8068 = As$. Then the angle sAm may be found; and two sides and a contain'd angle given in each, to find $Bm = 70.32$, and $Cm = 39.63$ feet the answer.* *L. T.*

Of

* The PRIZE QUESTION.

This question may be otherwise solved thus :

Putting $a = AB$, $b = AC$, and $r = Am$, as above; and also s and $c = \text{fine and cof. } \angle BAC$,

x and $\sqrt{1-x^2} = \text{fine and cof. } \angle BAm$, and

z and $\sqrt{1-z^2} = \text{fine and cof. } \angle CA'm$, to the radius r .

Then, by trigonometry, $\frac{ax}{r - a\sqrt{1-x^2}} = \text{tang. } \angle AmB$, and $\frac{bz}{r - b\sqrt{1-z^2}} = \text{tang. } \angle AmC$; but these angles are equal to each other by the question; therefore we have this equation, $\frac{ax}{r - a\sqrt{1-x^2}} = \frac{bz}{r - b\sqrt{1-z^2}}$.

D id 2

But,

Of the Eclipses in 1728.

There will be four eclipses this year; twice will the moon's dark body interpose between the sun and our part of the earth, and hide part of his face from our sight: and twice will the earth interpose between the sun and moon, and hinder the sun's enlightning the moon.

1. Moon eclipsed on Wednesday the 14th day of February, about 7 in the morning, visible.

	Begin.		Midd.		End	Digits
	h.	m.				
Astronom. Car. at Coventry	V	44	VII	10	VIII 36	9 32
Leadbetter, London —	5	49	7	13	8 48	9 13
Joh. Newton, Melt. Mobery	5	55	7	7	8 19	9 26
T. Sparrow, Nottingham	5	47	7	16	8 45	10 16
D's lat. north, descending	39'	47"			30' 28"	—

The

But, again by trigonometry, $z = s\sqrt{1-x^2} - cx$,

and $\sqrt{1-z^2} = sx + c\sqrt{1-x^2}$;

these values of z and $\sqrt{1-z^2}$ being substituted in the above

equation, we have $\frac{ax}{r - a\sqrt{1-x^2}} = \frac{bs\sqrt{1-x^2} - bcx}{r - bsx - bc\sqrt{1-x^2}}$;

which equation, reduced, gives

$$\begin{aligned}
 4a^2b^2x^4 - 4a^2brsx^3 + a^2r^2x^2 + 2a^2brsx + a^2b^2s^2 &= 0; \\
 + b^2r^2 & \\
 - 4a^2b^2 &- 2ab^2crs - b^2r^2s^2 \\
 + 2abcr^2 &
 \end{aligned}$$

from which biquadratic equation x may be found.

The moon will set about the middle of the eclipse, so that the end of it will not be visible to us.*

2. Sun eclipsed the 28th of February, at 8 at night, but invisible, by reason the sun is then set.

3. Moon eclipsed the 8th day of August, at 5 at night, the moon being then below our horizon. The eclipse will be over before she riseth, and so invisible.†

4. Sun eclipsed the 24th of August, at 1 in the morning, invisible.

New Questions.

I. *Question 130, by Mr. Rich. Whitehead.*

Near the place where I sojourn there happen'd of late,
Thro' time and neglect, a sharp cause of debate.

Three friends own'd a meadow, for so many years,
Till they could not determine the bounds of their shares.
A worm-eaten parchment, much gone to decay,
Was produc'd, full of lines, which they call'd a survey:
This was thumb'd, and look'd over and over again,
And with spectacles too, but alas! all in vain:
Nay, the schoolmaster's learning, tho' deep, nought avail'd;
And where shou'd they go when the schoolmaster fail'd?
Howe'er, being told that, my fancy to please,
I've us'd myself often with queries like these;

They

* This eclipse was observed

At *St. Michael the Archangel* by *J. de Castro Sarmiento.*

					h.	m.	s.
Beginning	—	—	—	—	14	3	35
End	—	—	—	—	17	0	37

† This eclipse was observed at *Pekin*, thus:

				h.	m.
Beginning of the penumbra	—	—	—	10	54
Beginning of the eclipse	—	—	—	11	2
End	—	—	—	14	0

D'd 3

They all said they'd treat me, and thank me to boot,
If I'd set the thing right, and end the dispute.

The mead had four sides, a tripezium or so,

As the musty old manuscript gave me to know:

These sides, east, west, north, and south, as they went,

The letters *A*, *D*, *E*, and *C* represent.

AD had six chains, forty links, (to go on)

EC twice five chains, links six, three, and one;

And *AC* contain'd chains twice seven, links none.

Two lines from the ends of the side *A* and *C*

Issuing, met, on the opposite side *E* and *D*,

At a point call'd, for sake of distinguishing, *B*,

And there form'd an angle (you know what I mean)

Equal the sum of sixty degrees, more by eighteen;

And after this manner were seen to divide

Into its three three-corner'd portions the mead.

Moreover, these lines their proportion thus bore;

BC to *BA*, was as three is to four;

BD to *BE* the same ratio did shew,

As three, in the scale of proportion, to two.

Phoo! said I, Mr. Pedant, don't know what his trade is;

If nonplus'd by this, he's no great Archimedes.

I shall soon set this matter to rights, I don't doubt;

But I found, after all, I was plaguily out:

I thought of this nature 'twas easy to do things,

But I find that speculation and practice are two things.

Of ye, Diarian fair, the favour I ask,

That you'd please to perform what I took for my task:

For me 'tis too much; but there's nought can surprize

Or pose you, whose wits are as bright as your eyes!

II. *Question 131, by Mr. Tho. Dod.*

A youth who in numbers some progress had made,

And took himself now for a notable blade,

Came with his progression*, and said he cou'd show,

How far a ball, constantly moving, wou'd go;

Which, says he, the first hour should go forty miles clever,

Thirty-five in the second, and so on for ever.

I allow'd he might do it, and bid him suppose

The ratio as 6 to . . . what I nor he knows;

And that it went so many † miles second hour:

Likewise this sum to his, be as nine is to four.

He try'd, and fell short, as a long thing to do:

So now he refers himself, ladies, to you.

* Geometrical.

† $46\frac{2}{3}$.

III. *Question 131, by Mr. John Hartley.*

In ancient times, when royal David's son
 Did reign in glory at Jerusalem,
 He built the spacious temple of the Lord,
 With implements, and rich utensils stor'd.
 A molten sea among the rest was made,
 For the priest's use intended, as 'tis said:
 Upon twelve brazen oxen it was set:
 Two thousand baths it wou'd contain; and yet
 A line of thirty cubits wou'd surround
 The same: It was cylindrical and round.
 The depth five cubits was, and hand's breadth thick:
 But the diameter I'm to seek;
 For tho' ten cubits be the number told,
 With the periphery this will not hold;
 For so the circumference you may see,
 Wou'd thirty-one and more than four-tenths be.

Now, I suppose, the jewish cubit was
 Longer than ours; but what's their bath, alas!
 Is hard to fix, since authors are divided:
 But ladies, by your arts 'twill be decided.

My first request, fair ladies, don't deny,
 The bath's content, and cubit's length descry?
 And these dimensions how I must apply,
 To make the sea two thousand baths contain,
 No arbitrary measures to retain,
 But what you from an author can maintain.

One favour more, once more I crave your aid;
 Suppose this molten sea of copper made,
 And full of water pure, I pray, declare
 What weight avoirdupois the oxen bear.

IV. *Question 132, by Mr. Tho. Williams.*

In Oxfordshire's a little meadow ground,
 A section of a parabola found,
 Having three sides; one curv'd, we'll call CM ,
 Being so made by Charwell's chrystal stream:
 The other two be'ng streight, did make connexion,
 In X the node, or focus of that section:
 But being streightly hedg'd, the last great flood
 Drove all that mound from off the ground it stood;
 Left nothing standing but a willow tree,
 And that, by chance, grow'd in the vertex C .

Since

Since which all ways are try'd for to regain
 The points M, X , but all, alas! prove vain.
 But this may useful be, the side CX
 Was found, before the flood, poles twenty-six;
 The square of which, they say, was equal to
 The meadow's area. Now we beg of you
 To give the side XM ; for till that's found,
 We can't again pretend to fix the ground.

V. *Question 133, by Τελώνης Πάλαι.*

Ye charming fair sex, to whom benign heav'n
 A bright and superior genius hath given;
 Whole luster in wit and art does appear,
 In the bright annals of the rolling year;
 Your aid's much desir'd: And you, sons of art,
 Your kind assistance pray please to impart
 To a young Philomath, who labours to find
 A right-angled triangle of such a kind,
 That when the doubled ale area on every side
 In its utmost extent (tho' never so wide)
 Being duly subducted, the remainders all three
 (From every side) a square number shall be.

Now, ladies, and artists, pray please to explain,
 When a vessel's erected upon such a plane,
 At ten inches depth, how much ale 'twill contain.

VI. *Question 134, by Mr. Tho. Grant.*

Ye British ladies, to whom all apply,
 As an oracle, in things abstruse;
 The greatest area that can b' inclos'd
 By four right lines, such as below are seen,
 Vouchsafe to tell: for surely you, or none,
 The deep mysterious secret can reveal.

[The lines 20, 16, 12, and 10.]

VII. *Question 135, by Mr. John Turner.*

In that delightful isle of old so fam'd
 For Cytherea's rites, thence Paphos nam'd;
 Inclos'd with flow'ry meads, a mountain stands,
 That casts a shadow into distant lands:
 In vain access by human feet is try'd,
 Its lofty brow looks down with noble pride

On fruitful Nile, tho' seven wide channels spread,
 And sees old Proteus in his oozy bed:
 Whose altitude if cub'd and multiply'd
 Into three times the square root of the side,
 Drawn from the mountain's vertex (till it be
 A tangent to the earth's convexity,
 Bounding the utmost prospect of the view)
 Produces what I in the margin shew. [1005'9309 miles
 If now the earth's radius supposed be
 In miles three thousand nine hundred sixty-three, [3963
 Artists, the mountain's height explain,
 Above the horizontal plain.

The Prize Question.

Bold Britons, boast no more of Bacchus here,
 Since he's dethron'd by Parson's humming beer;
 Straight abdicate him our dominions quite,
 And Parsons deify, as 'tis his right.

Let foreign dregs no more our sense invade,
 Which robs our stores, and spoils domestic trade:
 Champaign, Bourdeaux, and Burgundy no more
 Will be esteem'd as they have been before;
 His sov'reign, stout, and fine balsamic ale
 Excels that nectar did the gods regale.
 For sack no more the learned can inspire
 Like this same beer, with true poetic fire.
 'Twill make the courtier hate the fawning knave;
 The tim'rous soldier, valorous and brave;
 The canting whig, self-int'rest to despise;
 And heedless Tories, to become more wise;
 Make the mechanic new inventions find,
 And will inspire true Britons with one mind.

Henceforth, renowned Parsons, you shall be
 Esteem'd our patron, own'd a deity.
 Your stately cask to be your throne, from whence,
 To all your votaries, your laws dispense.

This spheroid cask, whose magnitude is such,
 The Trojan horse did not contain so much;
 For, by th' dimensions, it does plain appear
 To hold twice eighty * barrels of strong beer:
 Also the head's the latus rectum of its sphere.
 If you the diagonal from th' length subtract,
 Two feet two inches then remain exact.
 Ingenious artists, I this favour ask,
 To shew th' dimensions of this spacious cask.

* 160 barrels at 36 gallons to the barrel.

Questions

Then $2 : 3 :: m - a : g - e$ per question.

$4bb - 4ee = 4bh - 12hy + 9yy$ per Euclid 47. 1.

$9nn - ss - 4se - 4ee = 9hh + 18hy + 9yy :$

Putting $s = 3m - 2g$, and $w = 9nn - ss$,

We shall have $y = 2h - 2\sqrt{ab - ee}$,

$$\text{and } y = \sqrt{\frac{w - 4se - 4ee}{9}} - h.$$

And reducing the equation, $e = 3'43139$, y is found = $1'87239$, $a = 0'53966$. Hence $BD = 6'6411$, and $BE = 4'4274$ chains, and the whole $DE = 11'06850$.

A. R. P.

And the areas of $\begin{cases} ADB = 1 & 0 & 22'7667 \\ ABC = 5 & 3 & 1'3731 \\ CBE = 2 & 0 & 11'7145 \end{cases}$

Mr. R. Fearnside's answer is the same in every individual letter.

II. *Quesf.*

Demonstration.

The triangles BCE , BFD are similar by Eucl. VI. 7, and therefore $BE : BD :: BC : BF :: q : p$ by the construction; and the rest is also evident from the construction.

Calculation.

As $m + n : m - n :: \cotang. \frac{1}{2} \angle ABC : \tan. \frac{1}{2} \text{ dif. of the angles } BAC, BCA \text{ at the base; which added to and taken from half their sum, we obtain those angles themselves; and consequently the triangle } ABC \text{ becomes all known, which is one part of the field.}—\text{Then in the trapezium } BADF, \text{ are known all the sides and the } \angle ABF; \text{ to find the diagonal } BD; \text{ for } AD \text{ is given, and } AB \text{ and the } \angle B \text{ have been found; then by the con-}$

struction $q : p :: \begin{cases} CB : BF = \frac{p}{q} \times CB \\ CE : DF = \frac{p}{q} \times CE \end{cases}$. To determine

BD , draw AF ; then in the triangle ABF , given two sides AB , BF , and their included \angle , to find the third side AF and the $\angle AFB$. Then in the triangle ADF , are given all the sides, to find the $\angle AFD$; and the sum or difference of AFB and AFD will be the $\angle DFB$. Wherefore in the triangle DFB , are known two sides DF , FB , and their included angle, and consequently the whole triangle; which is the 2d portion.—Lastly, as $m : n :: DB : BE$; hence the 3d portion CBE is known.

II. *Question 131 answer'd by Mr. Tho. Grant.*

A ball moving 40 miles the first hour, 35 the second, and so on for ever in the same ratio, will go 320 miles. Then, by the question, as $4 : 9 :: 320 : 720$ miles = the sum of a decreasing geometrical progression, whose second term is $46\frac{1}{2}$ and last term = 0. Let x = the first term of the same; then, per Euclid 5. 12, 'twill be as $x : 46\frac{1}{2} :: 720 : 720 - x$. This, turned into an equation, gives $720x - xx = 33500$; whence $x = 50$ miles, and the common ratio as 6 to $5\frac{1}{2}$ or as 1 to $\frac{6}{7}$. Q.E.I.

III. *Question 131 answer'd by Mr. Turner.*

If a line of 30 cubits, or 656'64 inches, would surround the molten sea on the outside; then the outside diameter was but — — — — 209'015 inches

Twice the thickness of the } — 7'296
copper or 2 hand br. sub. }

Remains the inside diameter — 201'719

The depth 109'44 inches, area } 34311'982
of the base }

The whole solid content from } 3755103'31 cubic inches
outside }

Add the copper's bottom — 125170'11

The sum is — — — 3880273'42

Content of the inside — — 3497523'126

Difference — — — 382750'294

Equal to the cubic inches of copper. Divide the last sum but one by 2000, the number of baths it contained, gives the quotient 1748'76 cubic inches the content of one bath = $7\frac{1}{8}$ gallons wine measure; the whole contained 15140'8 gallons wine measure, or 60 tuns 20 gallons. Then according to Mr. Ward,

A cubic inch of { copper weighs 5'208369 } ounces avoird.
clear water 0'578697 }

Hence the weight of { water 56 tuns 8 hund. 12 pounds
copper 55 12 40 13
on the oxen 112 0 52 13

Q.E.I.

Answer'd

Answer'd by Mr. John Clark.

By Harris's Lexicon a { cubit is 21'888 inches
palm 3'648
bath 1747'700

whence the quantity of 2000 baths 3495400
water in the sea 3497504
difference 2104, which is but
 $\frac{6}{100}$ of an inch in the depth, or little more than one bath.

Then by Mr. Boyle's { of water is — T. c. ft. lb. dw. gr.
proportion the wt. { sides of the copper 37 2 7 4 59 16
and the bottom in proportion to the sides 18 1 0 1 173 9
The whole weight in avoirdupois — 112 4 5 4 146 9

* IV. *Question 132 answer'd by Mr. W. Milward.*

Let fall the ordinate MP , which call a , and put $CX = b = 26$ poles.

As $4b : a :: a : \frac{aa}{4b} = CP$ per conics.

$\frac{2CP \times PM}{3} =$ the area of the semi-

parabola $CPM = \frac{2aaa}{12b}$ or $\frac{aaa}{6b}$.

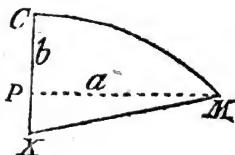
$CX - CP = PX = \frac{4bb - aa}{4b}$, and

$PX \times \frac{1}{2} MP =$ the area of the triangle PXM .

The $\triangle PXM +$ area of the semi-parabola = the area of the meadow, viz. $\frac{aaa}{6b} + \frac{4bba - aaa}{8b} = bb$ per question.

$aaa + 12bba = 24bbb$; here a is = 42'55 poles.

Hence $MX = 43'445$.



V. *Quef-*

* IV. QUESTION 132.

Putting $b = CX$, and $x =$ the ordinate PM ; then, by the nature of the parabola, $CP = \frac{x^2}{4b}$; and, by prob. 7 page 321

Mensuration, $CX + \frac{1}{3} CP \times \frac{1}{2} PM =$ the area = b^2 by the question; that is, $b + \frac{x^2}{12b} \times \frac{1}{2} x = b^2$, or $x^3 + 12b^2x = 24b^3$.

E e

* V. *Question 133 answer'd by Mr. Geo. Brown.*

Let a = side of the triangle; then $\frac{2aa}{282}$ = the double area. And suppose $a - \frac{2aa}{282} = 4$; which will admit of many answers, for when brought to a solution it will be $a - 70.5 = \sqrt{4970.25 - 564}$, and the greatest root take to be the utmost extent mentioned, viz. $a = 70.5 + \sqrt{4970.25 - 564} = 136.879$. And making this equation for the other side $a - \frac{2aa}{282} = 2.25$; then $a = 138.71$. And a vessel erected upon such a plane, at 10 inches deep, contains 334.49 ale gallons.

† VI. *Question 134 answer'd by Mr. Tho. Grant.*

Let $x = BD$, $a = AD$, $b = AB$, $c = CD$, and $d = BC$.

1. By the figure,

$$x : a + d :: a - d : \frac{aa - dd}{x} =$$

$DF - BF$, therefore

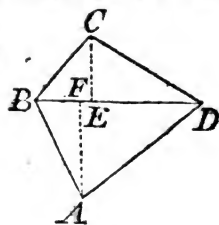
$$DF = \frac{xx + aa - dd}{2x}.$$

2. Again by the figure,

$$x : c + b :: c - b : \frac{cc - bb}{x} =$$

$$DE - BE, \text{ therefore } DE = \frac{xx + cc - bb}{2x}.$$

3. By



* V. QUESTION 133.

It is not clear what is meant by this question as it is worded; if double the area of the triangle is to be taken from each side, and the three remainders are to be squares, then solutions are given at question 638.

† VI. QUESTION 134.

By Theorem 12 of Simpson on the Max. and Min. of Geometrical Quantities, the trapezium will be greatest when it can be inscribed in a circle; and then, by rule 5 page 72 of my Mensuration, the area will be found thus: Half the sum of the given sides is 29, from which each of the sides being taken, we have the four remainders 9, 13, 17, 19; and the area $= \sqrt{9 \times 13 \times 17 \times 19} = 124.4$.

3. By Eucl. I. 47.

$$\sqrt{\frac{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}{4xx}} = FA.$$

4. By the same,

$$\sqrt{\frac{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4}{4xx}} = EC.$$

5. By the figure,

$$\frac{1}{4}\sqrt{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4} + \frac{1}{4}\sqrt{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4} = \text{the greatest area.}$$

6. The last in fluxions,

$$\frac{a^2xx + d^2xx - x^3\dot{x}}{2\sqrt{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}} + \frac{c^2xx + b^2xx - x^3\dot{x}}{2\sqrt{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4}} = 0.$$

7. This reduced is

$$\begin{array}{rcll} & -a^4 & +2a^2b^4 & \\ & -b^4 & +2a^2c^4 & \\ +2a^2 & -c^4 & +2a^4b^2 & -b^4a^4 \\ -x^8 + 2b^2 & -d^4 & +2a^4c^2 & -b^4d^4 \\ +2c^2x^6 & -4a^2b^2x^4 & +2b^2d^4x^2 & -c^4d^4 \\ +2d^2 & -4a^2c^2 & +2b^4d^2 & -c^4a^4 \\ & -4b^2d^2 & +2c^2d^4 & +4a^2b^2c^2d \\ & -4c^2d^2 & +2c^4d^2 & \end{array} \left. \vphantom{\begin{array}{rcll} & -a^4 & +2a^2b^4 & \\ & -b^4 & +2a^2c^4 & \\ +2a^2 & -c^4 & +2a^4b^2 & -b^4a^4 \\ -x^8 + 2b^2 & -d^4 & +2a^4c^2 & -b^4d^4 \\ +2c^2x^6 & -4a^2b^2x^4 & +2b^2d^4x^2 & -c^4d^4 \\ +2d^2 & -4a^2c^2 & +2b^4d^2 & -c^4a^4 \\ & -4b^2d^2 & +2c^2d^4 & +4a^2b^2c^2d \\ & -4c^2d^2 & +2c^4d^2 & \end{array}} \right\} = 0.$$

8. Or in numbers

$$-x^8 + 1800x^6 - 1076272x^4 + 222272000x^2 - 8768000000 = 0.$$

Hence $x = 21.187$. And the greatest area is 194.4 , &c.VII. *Question 135 answer'd by Mr. John Bulman.*Let $x = BA$ = the mountain's height.Then $x + 3963 = AC$.Hence $xx + 7926x + 15705369 = AC^2$.Or $xx + 7926x = AM^2$.

See Fig. to

Quest. 101

p. 244.

Consequently $\sqrt{81x^4 + 642006x^2} = 1005.9309$.

Then if the latter part of the equation at the last step be involv'd to the fourth power, and the radical sign taken away from the first part, the equation will be clear of furd's, and x may be found = 3 miles, the mountain's height required.

The same answer'd by Mr. R. Fearnside.

Put $a = AB$, $b = CB = 3963$, $e = AM$, $c = 1005.9309$.
Then $3a^3\sqrt{e} = c$, and $e = \frac{c^2}{9a^6}$. Then $ee = 2ba + aa$
 $= \frac{c^4}{81a^{12}}$, or $a^{14} + 2ba^{13} = \frac{c^4}{81}$; reduced, $a = 2.999999$
miles.

The Prize Question answer'd by Mr. Geo. Brown.

Let $AC = a$, $CE = LD = x$,
 $EE - AD = b = 26$ inches, $d =$
5760 the content, $c = 1077.15$.
 $4xx - 4bx + bb = AD^2$.

$$\sqrt{3xx - 4bx + bb} - a = DE.$$

$$3xx - 4bx + bb + aa -$$

$$2a\sqrt{3xx - 4bx + bb} = DE^2.$$

$$12xx - 16bx + 4bb + 4aa -$$

$$8a\sqrt{3xx - 4bx + bb} = DH^2.$$

$$\frac{24x^3 - 32bx^2 + 8bbx + 24aax - 16ax\sqrt{3xx - 4bx + bb}}{c} = d.$$

$$\frac{24x^3 - 32bx^2 + 8bbx + 24aax - dc}{c} =$$

$$16ax\sqrt{3xx - 4bx + bb}, \text{ and when squar'd } 576x^6 -$$

$$1536bx^5 + 1408b^2x^4 + 1152a^2x^4 - 512b^3x^3 - 48dcx^3$$

$$- 1536ba^2x^3 + 64b^4x^2 + 64bdcx^2 + 384b^2a^2x^2 +$$

$$576a^4x^2 - 16dcx - 48dca^2x + d^2c^2 = 768a^2x^4 -$$

$$1024ba^2x^3 + 256b^2a^2x^2.$$

And when aa is found in the unknown quantity x , there will be an equation of the 12th power affected; from whence the length is 156.2, diagonal 130.2, bung diameter 128.3, and head 82.1. *Q. E. I.*

Others have answer'd it as below.

	Length	Diag.	Bung	Head
Mr. John Bulman — —	157.25	131.25	128.8	81.72
Mr. James Clarke — —	160	134	127	88
Mr. John Rosser — —			126.01	76.5
Mr. John Finch — —	157		128.19	81.5
Mr. John Side-Bottom — —	163	137		81.5
Mr. John Hampson — —	157		128	81

The lot of 10 diaries fell to Mr. J. Finch, of Worcester.

of

Of the Eclipses in 1729.

There will be five eclipses this year: Three times will the dark body of the moon interpose between the sun and our earthly globe; and twice does the earth come between the sun and the moon, and hinder his rays from enlightning the moon.

1. Sun eclipsed on Saturday the 18th of January, at 6 in the morning, invifible to us by reason the sun is not rifen.

2. Moon eclipsed on Candlemas-day, the 2d of February, at 3 quarters after 8 at night, total and vifible.*

	Begin.	Begin.	Middle	End of	End.	Dura.	Digits
		tot. da.		tot. da.			
Astron. Carol. } Coventry	VII 4	VIII 3	VIII 50	IX 37	X 36	III 32	19 30
Chattock, Lond.	7 0	8 1	8 52	9 44	10 45	3 44	20 0
Leadbetter, dit.	6 57	7 58	8 44	9 30	10 31	3 33	19 17
J. Newton, Fl. } Ta. Melt.	7 4	8 4	8 53	9 41	10 41	3 37	19 46
J. Bulman, Roch.	7 12	8 11	8 58	9 45	10 44	3 32	19 31
Urania, N. Pag.	6 55	7 55	8 40	9 55	10 25	3 30	10 20

3. Sun eclipsed the 16th day of February, at 9 at night, but invifible, the sun being then fet.

4. Sun eclipsed on the 15th of July, invifible, being at 1 in the morning, when the sun is below our horizon.

5. Moon

* This eclipse was observed thus :

Place	Observer	Beginning	Tot. Im.	Emerfion	End
		h. m. s.	h. m. s.	h. m. s.	h. m. s.
Near Car- ricfergus in Irela. }	A. Dobbs } Etq. }	6 29 30	7 30 15	9 8 30	App. Time
Rome —	J. B. Carbone	7 44 22	8 43 17	10 21 38	11 20 41 tr.
Paris —	— —	7 3 0		9 41 18	10 41 24
Pekin —	— —	14 28 30	15 39 0	17 17 10	18 17 40

5. Moon eclipsed, total and visible, with continuance, on Tuesday the 29th of July, at 1 in the morning.*

	Begin.	Beg.to	Mid.	End.to	End	Durat.	Digits
		dark.		dark.			
Astron. Carol. } Coventry	XI 15	0 14	I 1	I 48	II 47	III 32	19 5
Leadbetter, Lond.	11 33	12 33	1 19	2 5	3 5	3 32	18 47
Chattock, Covent.	11 19	12 20	1 11	2 2	3 3	3 44	19 45
J. Newton, Mel. } Moberry	11 14	12 14	1 3	1 51	2 51	3 37	19 13
J. Bulman, Roch.	11 22	12 21	1 8	1 55	2 54	3 32	19 7
Urania, Newport	11 34	12 35	1 20	2 5	3 6	3 32	19 20

New Questions.

I. Question 136, by Mr. John Bulman.

When grateful heaven did on Henry smile,
The seventh of that name who rul'd this isle,
The mighty monarch (with an awful hand)
Two courtiers (known for treason) did command
That one to York, thrice fifty miles in length
From London; the other he to Stilton sent
From thence; (which places north of London lay)
They shou'd from the same moment take their way.
From thence a journey of a week they went;
Directly north, as by the King's consent:
Between the foremost man and London found,
By the last traveller, the space of ground,
Must in extreme and mean ratio run
As well at last, as when it first begun.

By

* This eclipse was observed thus:

Place	Observer	Beginning	Tot. Im.	Emerfion	End
		h. m. s.	h. m. s.	h. m. s.	h. m. s.
Wirtemb.	J. Weidler	12 1 30	13 1 0	14 40 30	15 40 0
Rome	—	12 1 0	13 0 16	14 39 24	15 38 0
Padua	J. Poleni	12 0 28	12 58 48	14 37 38	15 38 8ap.t.
Bononia	E. Manfredi	11 56 54	12 55 52	14 34 25	15 35 0tr.t.
Barbado.	Mr Stevenson	— — —	8 11 0	9 51 0	10 50 cap.t.

By Stilton then also the distance shall
Be in extreme, and mean proportional,
Between London and York; and to take place
To York, from Stilton is the greater space.

Fair ladies, then tell me by algebra,
Th' ratio of the swiftness of their way,
And from London to Stilton tell I pray.
And from York to Stilton 'tis intended
The miles to know, and this work is ended.

II. *Question 137, by Mr. John Simmons.*

The wine gallons that each body platonic will hold,
(The sides twenty-nine inches) some years since was told.
A wager is laid me, were each side an inch more,
'Twould puzzle my noddle, the same to explore.
I've try'd many ways, but in vain, for I find
My money is lost, if not help'd by some friend,
On whose skill, in the case, I may safely depend.
Now, gentlemen gaugers, pray shew me your art,
And in the next Diary be pleas'd to impart,
What each body wou'd hold, were a globe in its belly
(The ambient sides touching;) and also pray tell me
The number of gallons each sphere will contain,
That wou'd nicely inclose each body — make plain.

III. *Question 138, by Mr. Tho. Grant.*

When Argo, fraught with the enchanted prize,
With Grecian heroes, and with Medea wife,
Had weigh'd her anchor, and her canvas spread,
A golden apple at the fore-mast-head
Sublime they place; their vict'ry to proclaim.
They sail in triumph o'er the passive main,
With equal pace; when, by mischance, the ball
In three half seconds to the deck did fall;
During which time they plow the yielding deep,
The length of five and twenty Grecian feet.

Now tell me, ladies, who have arts at will,
The space's length thro' which the trophy fell?

IV. *Quest-*

IV. *Question 139, by Mr. Tho. Williams.*

Not far remov'd from fam'd Oxford, the eye
 And Athens of our British isles, doth lie
 A little right-lin'd field triangular,
 Whose pregnant mould uberous crops does bear.
 This, by a father's will, I must divide
 Betwixt two sons, who will not be deny'd;
 Because they've heard much of my boasted skill,
 How I with ease such problems cou'd fulfil:
 For I am apt to talk more than I know,
 As most conceited fools are wont to do.

Now, to distinguish angles, we will call
 Them *A, B, C*, in manner as they fall:
A, that is known; the side *AB* is giv'n;
 One eighty-two degrees, t'other chains thrice sev'n:
 From *A* the parting fence must go to *D*,
 Cutting the angle *A*, and side *BC*,
 That *BAD*, to *DAC*, may in
 Proportion be, as twelve is to eighteen:
 And that *BD* to *DC*, may also
 Be in the ratio just of three to two.
 Hence, I'm to shew what lengths each side will bear,
 And how much land will fall to each son's share.
 I know it may be done, but cannot do't,
 Nor will my boasted rules here help me out;
 So, ladies, with submission I implore
 Your aid this once, and I will ask no more:
 For you or none (whose wits so bright appear)
 Can keep my credit up, now lost so near.

V. *Question 140, by Mr. John Lowe.*

Suppose there be a pyramid erected upon a triangular base, whose longest side is eighty-eight inches, and the angle opposite to the longest side is eighty-five degrees and one minute, and the rectangle of the other two sides added to their sum is four thousand one hundred and three inches; and the pyramid's greatest angle of altitude, is in proportion to its least, as seven is to six: What is the difference, in ale gallons, betwixt the greatest cylinder and sphere that may be inscribed in the said pyramid?

VI. *Quest.*

VI. *Question 141, by Mr. Will. Browne.*

What three numbers are those, ladies, do you suppose,
 That the square of the first, and indeed,
 The rectangle of the first and the second may just
 Make the sum of a score, is agreed?
 And the second, you must know, being squar'd, as you go,
 And the product of the second and third,
 Will make a whole score, and half a score more,
 When added, I'll give you my word.
 And the third, pray regard, when as it is squar'd,
 And the first in the third multiply'd,
 The sum will make out, two score, without doubt,
 Algebra will shew you, when try'd?

VII. *Question 142, by Mr. John Ingleborough.*

The great tun at Heidelberg, an author says, held as much wine in its entrails as the Colossus of Rhodes held water between its thighs. It is 31 feet long, and 21 high.

Now supposing the tun to be of the same shape with Parsons's cask, mentioned last year, so far as may agree with the dimensions above; how many gallons of wine wou'd it contain? Secondly, supposing Parsons's cask of stout to equiperorate with the Heidelberg tun of wine, suspending from a ballance 60 feet long; what wou'd the difference of the brachia of the balance be? And thirdly, supposing it were requir'd that each vessel shou'd evacuate itself exactly in two hours by a hole in the lowest place; what must the diameter of each bore be, that so the vessels may hang in equilibrio all the time the liquor is running out, not admitting the weight of the vessels to interfere or make any variation?

The Prize Question.

A certain courier being at Montpelier,
 (So fam'd for its excellent spaw)
 Ere that place he leaves, an order receives,
 Express unto Turin to go.
 Now its very well known, that the river of Rhone,
 Which betwixt the two places doth lie,
 Runs due north and south, quite down to its mouth,
 Through Provence and through Dauphiny:

Mont.

Montpelier, 'tis manifest, lies forty miles west,
 And no more, from the river of Rhone;
 And Turin is plac'd one hundred and fifty due east,
 From the same, as with ease may be shown.
 Likewise the true space, from that to this place
 (Because that we ought to define)
 Is two hundred miles just*, (if fame we may trust)
 When measur'd upon a streight line.
 Now the gentleman knows, that as long as he goes
 On the western side of the river,
 It is in his power, to ride three miles on hour,
 If he but exert his endeavour.
 But on the orient he must be content,
 (When he has done all in his power,
 It being a tedious and troublesome way)
 To take up with two miles an hour.
 Now, ladies, discover, the point to pass over,
 That the river such wise may be crost,
 That he may prosecute his journey throughout,
 And the fewest of moments be lost?
 That's, what may be the intermediate space
 From the said point to each respective place.

* 200 miles from Montpelier to Turin.

1730.

Questions answer'd.

I. *Question 136 answer'd by Mr. Rob. Fearnside.*

THE distance between York and London given 150 miles;
 from London to Stilton will be easily found 57.2949
 miles; and Stilton to York 91.7051. Put y = the space
 passed

* I. QUESTION 136.

The meaning of this question is, To divide 150 miles into two parts in extreme and mean proportion; and to find the ratio of the equable velocities, by which the less part and the whole length may be passed over in the same time.

Put

passed over by the courtier bound to Stilton, in any moment of time; and x = the space passed over by him bound for York in the same moment of time. Then, per question, $xx - 2xy + yy = xy$, in fluxions $2xx - 3xy - 3yx + 2yy = 0$. Reduced to an analogy, $y : x$ (the fluxion of any flowing quantity being taken for its velocity) $:: 2x - 3y : 3x - 2y$. That is, as 128'1242 to 335'4161.

II. Question 137 answer'd by Mr. Tho. Grant.

Names of the bodies	Capacities	Inscrib'd spheres	Holds besides the spheres	Ambient spheres content
	Win. gall.	Win. gall.	Win. gall.	Win. gall.
Tetrahedron	13'77	4'16	9'61	112'43
Hexahedron	116'88	61'20	55'68	318'00
Octohedron	55'09	33'08	42'01	173'09
Dodecahedron	895'69	676'00	219'69	1347'09
Icosahedron	255'00	211'34	43'65	421'17

Mr.

Put x = the less part, and a = 150 the whole. Then $a - x$ = the greater part; and, by the question, $x : a - x :: a - x : a$; hence $ax = a^2 - 2ax + x^2$, and $x = \frac{3 - \sqrt{5}}{2} \times a$ = the less part. Therefore $a - x = \frac{\sqrt{5} - 1}{2} \times a$ = the greater part.—Hence

The two parts of any quantity which is divided into extreme and mean proportion, are in the ratio of $\frac{3 - \sqrt{5}}{2}$ to $\frac{\sqrt{5} - 1}{2}$, or of $3 - \sqrt{5}$ to $\sqrt{5} - 1$, or of 1 to $\frac{\sqrt{5} + 2}{2}$, or of $\frac{\sqrt{5} - 2}{2}$ to 1.

And the less part to the whole, as $\frac{3 - \sqrt{5}}{2}$ to 1; which is the ratio of their velocities or rates of travelling required.

* II. QUESTION 137.

In the *Scholia* at page 403, &c. of my *Mensuration*, the true values of the content of each regular solid, with that of the radius of the inscribed and of the circumscribed sphere, are expressed in terms of the linear edge or side; whence the numbers, as above, may be easily found.

Mr. Grimmer, Mr. Hurd, Mr. Bulman, Mr. Sidebottom, Mr. Colbourn, Mr. Brooke, Mr. England, Mr. Brown, Mr. Bruin, Mr. Sparrow, Mr. Lovat, Mr. Eyre, Mr. Fairchild, Mr. King, Mr. Armstrong, Mr. Battersbee, Mr. Hale, Mr. Mason, and several others, answer'd this question.

* III. Question 138 answer'd.

The ball descending with a compound force, that is, an horizontal force by the motion of the ship, and by the force of gravity; the spaces described by such motions are analogous to the abscissas and their respective semi-ordinates, in the conic parabola, and the motion will be in the curve of the same.

Then there is given the abscissa $= x = 434.25$ inches = the space described in three half seconds by the force of gravity only; and its semi-ordinate $= y = 25$ Grecian feet $= 302.1$ inches English. Whence by fluxions

$x + \frac{5y^2}{8x} + \frac{3y^4}{128x^3} - \frac{3y^6}{256x^5} + \frac{y^8}{2648x^7} \&c. = 567.42$ inch.
or 47.285 feet, the space the ball descended.

IV. Quest-

* III. QUESTION 138.

The 25 Grecian feet are $= 25 \times 1.007$ or 25.175 English feet = the horizontal motion, or the ordinate of the parabola, which call $2y$; and as $12 : \frac{3}{2}^2$, or as $4 : 9 :: 16\frac{1}{3}$ feet : $36\frac{3}{8}$ feet = the perpendicular descent, or the abscissa of the parabola, which call x . Then, by Cor. 1 page 310 of my Mensuration, the true length of the curve will be $\sqrt{x^2 + y^2} + \frac{y^2}{x} \times \text{hyp. log. of}$
 $\frac{x + \sqrt{x^2 + y^2}}{y} = 45.9578$ feet = the length of the line described by the ball.

* IV. QUESTION 139 answer'd by Mr. Rob. Fearnside.

Put $AB = 21$ chains $= b$, the natural sine of the angle BAC (the radius being an unit) $= 82^\circ = 0.990268 = t$, the natural sine $\angle CAD = 49^\circ 12' = .756995 = s$; and $BC = c$.

Then as $c : t :: b : \frac{bt}{c} = \text{fine } CD$
 $\angle ACD$. Again, as $s : CD (= \frac{2}{5}c) :: \frac{bt}{c} : AD = \frac{2bt}{5s} = 10.988$. On AC let fall the perpendicular Bp . And lay as $b : 1 :: t : Bp = 20.795$. Consequently Dd is $= 8.318 = \frac{2}{5}Bp$, $CD = 13.1837$, the area of the $\triangle ACD = 4.166$ acres, and of the $\triangle ADB$ is $= 6.249$ acres.

V. QUEST-

* IV. QUESTION 139 calculated otherwise.

The $\angle BAD = \frac{2}{3}$ of $82^\circ = 32^\circ 48'$, whose sine call a ; and $\angle CAD = \frac{1}{3}$ of $82^\circ = 49^\circ 12'$, whose sine call s ; also $t = s$. $\angle BAC$ or 82° , and $b = AB = 21$ chains as above. Then, also as above, $AD = \frac{2bt}{5s} = 10.9885$: And hence $\frac{1}{2}AB \times AD$

$\times s$. $\angle BAD$ or $32^\circ 48' = \frac{abbt}{5s} = 62.502$ square chains $= 6.2502$ acres $= \triangle ABD$.

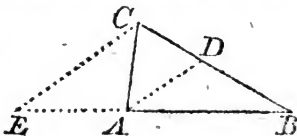
Again, as $AB + AD : AB - AD :: \cot. \frac{1}{2} \angle BAD$ or $\cot. 16^\circ 24' : \text{tang. } \frac{\angle ADB - \angle B}{2} = 45^\circ 5'$; which added to

$73^\circ 36'$ half the sum of these two angles, we have $118^\circ 41' =$ the $\angle ADB$; and this taken from 180° , there remains $61^\circ 19'$ for the $\angle ADC$. Then, as s . $\angle BDA : s$. $\angle BAD :: AB : BD = 12.967$; the 2-3ds of which is $DC = 8.645$. Hence $\frac{1}{2}AD \times DC \times s$. $\angle ADC = 41.648$ chains $= 4.1648$ acres for the other part ACD . And, lastly, as s . $\angle CAD : s$. $\angle D :: CD : CA = 10.0135$.

Construction.

Having drawn the given side AB , and the lines AD , AC making the given angles BAD , DAC ; in BA produced take AE to AB in the given ratio of CD to DB , that is, of 2 to 3; draw EC parallel to AD ; lastly draw CB , and it is done.

For, by sim. $\triangle s$, $AB : AE :: BD : DC$.



VI. QUESTION 141 *answer'd by Mr. Lovatt.*

This question may be found in Mr. Kersey's Algebra, p. 299. We have given $aa + ae = 20$, $ee + ey = 30$, and $yy + ya = 40$; which will give $\sqrt{40 + \frac{1}{4}aa} - \frac{1}{2}a = \frac{70aa - 400 - a^4}{20a - aaa}$; and reduced is $a = 3.051$, $e = 3.526$, $y = 4.98$.

* VII. QUESTION 142 *answer'd by Mr. Rich. Lovatt.*

The length 372 inches = d , bung diameter = 252 = b . If the cask be the same shape as Parsons's, the head is the latus rectum; then $\sqrt{dd - bb} : b :: b : 141.334$ = the head per conics: finding an infinite number of ordinates 'twixt head and bung, will constitute the solidity = 59780.4 wine gallons, and a mean of all those ordinates will give an equal cylinder = 217.3072 inches. A gallon of wine weighs 8.29645 pounds avoirdupois. Then $8.296 \times 59780.4 = 495965.1593604$, the whole weight: A gallon of stout weighs 10.25 pounds avoird. $\times 5760 = 59040$, the weight of the liquor in Parsons's cask. Then as the sum of the weights is to the difference, so is the length of the balance to the difference of brachia = 47.2348 feet. From Parsons's cask the liquor flows 128.8 inches, equal bung diameter, in 34.218 thirds of time, Heidelberg cask flows 252 inches in 47.863 thirds. Then put $d = 432000$, the thirds in 2 hours, $n = 34.218$, a = the drain of the bore in Parsons's cask. And then $\frac{128.8 daa}{359.05 n} = 5760$; hence $a = 1.127$ inch. And by the same way the bore is found 2.78119 inches in Heidelberg cask. Mr. Tho. Grant makes the bores 3.387 and 1.3518 inches.

The

* VII. QUESTION 142.

The dimensions of the apertures, as determined in the solution to this question, may perhaps be pretty near the truth: but as for the mathematical certainty, there does not seem to be a possibility of it in the case.

* *THE PRIZE QUESTION answer'd by Mr. John Fearnside.*

Put $AB = c$, $CD = d$, $BC = b$, and $CE = b - x$. Then,

per 47 Euc. 1. $AE = \sqrt{cc + xx}$;

and $DE = \sqrt{dd + bb - 2bx + xx}$.

Then, by the question, $2 : 1 ::$

$\sqrt{dd + bb - 2bx + xx} :$

$\sqrt{dd + bb - 2bx + xx}$, and

$\sqrt{dd + bb - 2bx + xx}$, and

$3 : 1 :: \sqrt{cc + xx} : \sqrt{cc + xx}$. Therefore

$\sqrt{dd + bb - 2bx + xx} + \sqrt{cc + xx} = 0$: which

thrown into fluxions, and reduced, $x = 18.5723$, $CE = 43.8776$, $AE = 44.1015$, and $DE = 156.286$; and the time in going the whole journey 92 hours 50 min. 30 seconds : Which agrees to the ingenious proposer Mr. Turner, and several others.

On Candlemas-day last the lot of 10 diaries fell to Mr. John Bulman of Lewisham, Kent.

Of

* *THE PRIZE QUESTION.*

This problem may be seen applied to various and very curious purposes in *Hayes's Fluxions*.

Of the Eclipses in 1730.

In this year will happen five eclipses: three times will the moon's opaque body interpose between the sun and earth, and hinder his rays from falling on the inhabitants: and twice will the earth come between, and prevent the sun's enlightening the moon.

1. Sun eclipsed the 7th day of January, between 6 and 7 at night, but invisible to us, because 'tis set.*

2. Moon eclipsed on Friday the 23d of January, at 3 in the morning, visible.†

Computed by.	Begin h. m.	Midd.	End	Dur.	Dig.
By Astronom. Carol. Coventry	III 7	III 0	III 53	I 46	2 39
Mr. Chattock, London	2 29	3 42	4 50	2 24	4 24
Mr. Leadbetter, London	2 37	3 33	4 30	I 52	2 53
Mr. J. Darley, Nottingham	3 2	3 56	4 50	I 48	2 45
Mr. J. Bulman, Lewisham in Kent	3 13	4 6	4 59	I 46	2 39
Mr. Wm. Brown, Bridgenorth	3 3	3 56	4 50	I 47	2 38
Mr. Williams, Middleton Story	2 31	3 44	4 51	2 25	4 40
Mr. Christ. Fairchild, Spalding	3 4	4 1	4 58	I 54	3 0
Mr. J. Newton, Melton Moberry	2 31	3 34	4 36	2 53	3 37

3. Sun

* This 1st Eclipse was observed in *Paragua*, in *South America*, by *F. Bon. Suarez*, thus:

True time.
h. m. s.
Beginning 2 52 30 *p. merid.*
8 digits at 4 7 33
0 dig. 30' — 4 50 0

The end was not observed because of clouds; it seems to have been at 4h. 52m. At about 4h. 55m. the disc of the sun was seen entire. The greatest obscuration seems to have been $8\frac{1}{2}$ digits.

† This 2d Eclipse was observed at *Lisbon*, by *P. J. Bapt. Carbone*, thus:

F f 3

Temp.

3. Sun eclipsed on saturday july the 4th, at 3 quarters after 3 in the morning. The latter part of which, if the air proves favourable, will be visible: It rises eclipsed, near 5 digits, at 3 hours 36 min.*

Computed by	Begin.	Midd.	End	Dur.	Dig.
Astronom. Carolina. Coventry	II 52	III 41	IV 32	I 40	5 49
Mr. Chattock (by Sci. Stet.) Cov.	2 36	3 25	4 17	I 41	6 5
Mr. Leadbetter, London	2 36	3 26	4 18	I 41	6 7
Mr. Jos. Smith, { London Constantinople	over bef. ☉	rise	4 30		4 30
Macao in Japar	1 14	2 50	4 10	2 56	11 0
Mr. C. Fairchild, Spalding	2 50	3 34	4 32	I 42	4 56
Mr. J. Newton, Melton Mobery	2 40	3 29	4 22	I 42	5 51
Mr. J. Bulman, Lewisham,	2 23	3 28	4 29	2 6	6 1

The fourth of the moon, july 19th, at 4 aftern. invisible †

The fifth of the sun, december 28, at 10 in the morning, invisible, because of the moon's great parallel of latitude.

New.

Temp. Ver. p. merid.

h. m. s.

13 25 0 Incipit penumbra sensibilis.

13 40 0 Fit spissior.

13 58 0 Fit spississima.

14 3 45 Dubitatur de eclipsis initio.

14 4 32 Nunc certo incipere videtur.

16 4 0 Finis eclipsis.

Duratio eclipsis 4 h. 59 m. 28 s.

Medium eclipsis 15 h. 4 m. 16 s.

Quantitas, dig. 3 min. 20, ad Boream.

* This 3d Eclipse was observed

1. At Wirtemberg by Mr. J. F. Weidler.

Dig. 4 a 4 h. 50 m. 15 s. Temp. ver. ante merid.

Finis — 5 15 30

2. At Padua by Mr. J. Polenus.

Dig. 4 a 16 h. 46 m. 12 s. Temp. ver.

Finis — 17 6 8

3. At Peking by F. Ignat. Kegler and Andrew Pereyra the end was observed at 2 h. 27 m. 10 s.

† This 4th Eclipse was observed thus :

	Begin.	End
At Chemxo in Nankin by P. Jac. Simonelli	10 h. 55 m.	12 h. 49 m.
— Cocbinchina by P. Franc. de Lima	9 48	11 50

New Questions.

I. QUESTION 143, *by Mr. Tho. Battersbye.*

There is a right-lined triangle, in which a circle is inscribed; and in the corners of the triangle are placed three little circles, so drawn as to touch the adjacent sides of the triangle, and the greater circle, whose diameters are 484, 441, and 400. It is required to find the sides of the triangle, and the diameter of the greater circle?

II. QUESTION 144, *by Mr. Will. Massey.*

A painter of skill, and much fame in the town,
Had procur'd himself work for more hands than his own,
He employ'd an assistant, to help him in part;
A proficient in every branch of his art.

O'er a glass of good wine upon terms they debate,
And the bottle was drain'd while they state and unstate:
For as plenty of Bacchus's enlivening juice,
Does most commonly projects and whimsies produce;
So when that their spirits grew warm with the liquor,
Fresh maggots were started, and fancies flow'd quicker,
They were long in contriving what both sides cou'd please,
And at length the proposals agreed on were these:

For a single year's service the man shou'd be ty'd;
And for every day that he full was employ'd,
Seven shillings per day shou'd his wages be paid;
But for all such as those when he rested or play'd,
He shou'd forfeit three shillings: The year was compleat,
Neither master nor man was in each other's debt.
Now, what time he neglected, fair artists, is sought,
And how much for his master in painting he wrought?

III. QUESTION 145, *by Mr. Rob. Fearnside.*

Two ships *A* and *B*, west and east from each other,
Were bound to a port that they cou'd not discover;
To do which the ship *A* takes her way as below*, ($*8\frac{1}{4}$ leag.
Betwixt north and east, but what point do not know,
Till she found the port north (for distinction call *D*)
Of herself and the place where she left the ship *B*;
Which soon as espy'd, the ship *B* anchor weigh'd,
And sailed due east as is here display'd, ($12\frac{1}{2}$ leaguer.

But

But despairing to see the port *D*, furls her sails,
 As other ships use to do when nought avails;
 While *A* ploughs the ocean but slowly along,
 But by some chance or other the space was unknown,
 Tho' her course, or the point of the compass the same
 That she sail'd from the very first place that she came:
 Till by observation *DB*, as before,
 The contrary points of the compass they bore
 Of ship *A*, who was just five leagues from the shore.
 And since I have found that the space in the sea
 Whence *A* first set sail, and the anch'ring of *B*
 (If *D* be made center) includes a fourth part
 Of the mariners compass; or if with less art,
 To those who ne'er sail'd, I shou'd better explain
 The distance, a right angle just doth contain.
 Now, ladies, the distance betwixt the port-*D*,
 And where *A* did first sail from, as also of *B*;
 And likewise the course of ship *A* let be known?
 And aught in the Indies pray claim as your own.

IV. QUESTION 146, by Mr. Tho. Grant.

Ye learned fair, to whose all-piercing minds
 Abstrusest things are known; be pleas'd to show
 A gen'ral method, that with equal ease
 May the equation * under-written solve,
 Or any other of the same degree.

$$* x^x = 123456789.$$

V. QUESTION 147; by Mr. Tho. Williams.

In thirty-one, the ninth of june,
 Happens a small eclipse o'th' moon;
 Which to define I don't intend,
 When 'twill begin, middle, or end,
 Et cætera: but leave such matters
 To hogenous moghen calculators;
 And only here in short to tell you,
 What I have done, and you've to do:
 For having drawn as shou'd be done,
 The mundane shadow, and the moon,
 When she is most immers'd therein,
 As likewise when it does begin;
 And finding these three wou'd explain
 The matter that I thought to gain;

I join'd

I join'd their centers with lines that
Made a rectangle triangulate,
Whose base and perpendicular,
Three minutes made above fourscore;
Likewise hypotenuse and base
Sixteen above fivescore t'an ace.

Hence, you're to shew each sep'rate side,
How much the terrene shadow's wide;
How much the moon's diameter,
And how much dark of her'll appear?
But one thing more I must disclose,
Lest you shou'd miss, that is, if four's
Added to the perpendicular,
'Twill make the moon's diameter..

VI. QUESTION 148, *by Mr. Tho. Sparrow.*

Come, Athens sons, shew me how to find the place where
(Betwixt here and the moon) that an unactive sphere,
Depriv'd of all motion shall in equilibrio depend;
By those two globes attraction, and neither descend;
And give an example (if you think it fit)
When the moon is the nearest the orb will admit.

VII. QUESTION 149, *by Mr. Rich. Lovatt.*

Assist, ye muses nine, grant me your aid.
To speak in verse, for truly I'm afraid;
My tongue wants eloquence for to declare
How much of praise is due unto the fair.

If the sun's altitude be thirty-three,
On june the third, and the hour angle be
Equal co-latitude; from whence I pray,
Give me a theorem, with the hour o'th' day.

VIII. QUESTION 150, *by Mr. John Turner.*

There is a meadow in form of a parabola, the abscissa of which is equal to 40 chains, and the greatest ordinate (that which bounds the meadow) is 72 chains, from whence the latus rectum will be found 32.4 chains. It is required to inscribe such a parallelogram in this parabola, as that its area may be greater than the area of any other parallelogram that can possibly be inscribed in the said parabola, and to give the analytical investigation of the same?

IX. QUES.

IX. QUESTION 151, by Mr. Chr. Mason.

In a fair vale where fruitful fields appear,
 And Flora's beauties flourish round the year;
 There dwells, and long has dwelt, an aged fire,
 Where the same race six cent'ries did expire.
 There his own land with his own cattle tills;
 No weight of wealth, nor poverty he feels;
 The wiseman's wish he makes his highest aim;
 A frugal plenty still supplies the same.
 His youthful years in useful arts did spend,
 T' improve his judgment, and instruct his friend;
 That his gen'ration might him useful find,
 And live to die, as the great God design'd.
 Recluse from balls, from masquerades, and court,
 Where vice triumphant, with her tools resort;
 Despis'd the town, where fops and cullies roam,
 And with his choice sedately staid at home.
 Now with delight as hoary years arrive,
 He sees his sons with emulation strive
 Who shall his morals nearest imitate,
 Whilst he with problems them does stimulate,
 And they with expectation for his praises wait.
 He well observes, and warily does praise,
 Lest he shou'd strife, not emulation raise.

With winning ways he calmly does correct,
 Lest thro' reproof his council they reject:
 As thus the sire, — ' My sons, I you advise,
 ' Fair virtue chuse, deluding vice despise;
 ' Let the great God with rev'rence be ador'd,
 ' Be art your sport, and live in one accord.
 ' To what each genius by nature made,
 ' Be that his art, his calling, or his trade;
 ' And then with patience prudently pursue,
 ' Few years will gain what ages never knew.
 ' And now, fair youths, with vigour make't appear,
 ' Which of your brows the paper crown shall wear:
 ' Resolve this * quere, which I here propose;
 ' Your pious mother's and my age it shows.

$$\left. \begin{aligned} &\{aaaa + aaaa = 3800000000 = b.\} \\ &\{cccc + cccc = 4067442500 = c.\} \end{aligned} \right\} \text{Quere } a \text{ and } c?$$

The PRIZE QUESTION.

Last Candlemas-eve, the eclipse of the moon
 Made her talk'd of much more than wou'd else have been
 Her vulgar admirers all guess'd at her nature; (done;
 By which it appear'd, they knew nought of the matter :
 Some computed her age, but at four weeks just,
 When a new one was made, 'cause the old one was lost :
 Others thought this a costly, and wastable trade;
 And urg'd that new stars from the old ones were made;
 But this was retorted with squibs, and with jeers,
 Can dotted old moons make shining new stars?
 So whatever one said was oppos'd by another,
 Which was likely to make a most damnable pother:
 When a glover starts up, and thus spoke t'her honour,
 And after this sort, he commented upon her.

Good neighbours, the moon is a world I dare swear;
 And let any presume to deny't if they dare :
 The great bishop Wilkins hath prov'd what I said;
 Nay, I'd fetch you his book, if I thought you cou'd read :
 Then cease your dull whimsies, and study with me,
 How to settle a trade betwixt they and we :
 Shou'd we lose Gibraltar and the port of Mahone,
 Pray judge the advantage of a trade to the moon.
 The noise was streight hush'd ! a deep silence began !
 For all gazing stood, and admired the man :
 Such heads being at work, we need not to fear,
 But we shall soon have ships sailing up in the air;
 And the way, without doubt, most easy be made;
 And the world of the moon, Great Britain's chief trade.

But some few things I cou'd wish, were put in good light,
 For informing our factors and merchants aright;
 Which far harder may prove than their tare and their tret,
 And if ignorant on't, they nothing may get;
 But their profit and loss, and terms us'd in books,
 When screw'd into metre, but aukwardly looks :
 So for want of fit words for to gingle and chime,
 I'll quere in prose, and cease my dull rhyme.

Suppose at the time above *A*, *B*, and *C* make a stock of
 21650 hundred weight, and it's sold at the moon for 2336193 *l*.
 9*s*. 7*d*. $\frac{1}{8}$, being sold at a hundred times more per ton than
 it cost; and suppose the price of *A*'s stock in pounds be the
 square root of the stock of *B*; and the stock of *A* and *B*, the
 square root of the stock of *C*. Quere each man's stock and
 gain, and the weight of the goods at the moon; and because
 if the same goods, at the same price, had been sold at the
 globe of Jupiter, the amount had been 9108924 *l*. Quere the
 weight at his body also?

Questions

1731.

Questions answered.

I. QUESTION 143 answer'd by Mr. Rich. Lovet.

$$\text{Given } \begin{cases} NH = 220.5 = dd, \\ GC = 242 = nn, \\ FM = 200 = hh, \\ EL = aa, \end{cases}$$

Per 47 Eucl. 1, we have
 $a^4 + 2aadd + d^4 - a^4$
 $+ 2aadd - d^4 = 4aadd$
 $= HD^2$, and $\therefore 2ad =$
 HD .

Again $aa - dd : 2ad ::$

$$aa : \frac{2a^3d}{aa - dd} = BL.$$

$$\text{Hence } \frac{2a^3d}{aa - dd} + \frac{2a^3n}{aa - nn}$$

$$= BP, \quad \frac{2a^3d}{aa - dd} + \frac{2a^3h}{aa - hh} = BQ, \quad \frac{2a^3n}{aa - nn} + \frac{2a^3h}{aa - hh}$$

$$= PQ.$$

$$\text{Or } BP = \frac{2a^5d - 2a^3dn^2 + 2a^5n - 2a^3nd^2}{aa - dd \times aa - nn};$$

$$\text{Suppose } \begin{cases} m = 2d + 2n, \\ k = 2n^2d + 2nd^2; \end{cases}$$

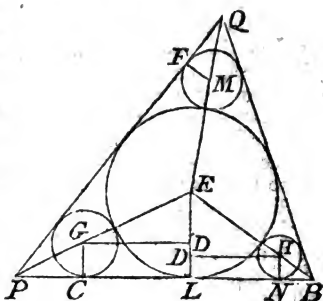
$$\text{And } PQ = \frac{2a^5h - 2a^3hn^2 + 2a^5n - 2a^3h^2n}{aa - nn \times aa - hh};$$

$$\text{Suppose } \begin{cases} c = 2h + 2n, \\ p = 2hn^2 + 2nh^2. \end{cases}$$

$$\text{Hence } \frac{BP + PQ + QB - 2PB}{2} \times \frac{BP + PQ + QB - 2PQ}{2}$$

$$= \frac{4a^6dh}{aa - dd \times aa - hh}.$$

But



But $aa + nn : 1 :: aa - nn : \frac{aa - nn}{aa + nn} = s. \angle EGD;$

and, by that curious theorem 31 in Spherical Triangles explained by Ozanam, vol. II. p. 142) which holds good in

all triangles, we have $\frac{a^4 cm - aack - aamp + pk}{a^4 - 2aann + n^4}$

$$: 1 :: 4dh : \frac{aa - nn}{aa + nn}^2;$$

Hence $a^4 cm - 4a^4 dh - aack - aamp - 8aann dh = 4n^4 dh - kp$. Sub. $b = ck + mp + 8nndh$, and $l = cm - 4dh$;

$$\text{Then } aa = \frac{b}{2l} + \sqrt{\frac{4n^4 dh - kp}{l}} + \frac{bb}{4ll} = 661 = EL.$$

And the lines are $2aa = 1322$, $PB = 2407.85$, $BQ = 2188.48$, $PQ = 2304.72$.

* II. QUESTION 144 answer'd by Mr. Geo. Anderson.

Let $b = 365 =$ the number of days in a year, $a =$ the number of days wrought; then $b - a =$ the number of days play'd; therefore $7a = 3b - 3a$ per question. Whence a will be found $= 109.5$ days wrought; and $255.5 =$ the days play'd.

III. QUESTION 145 answer'd by Mr. Geo. Anderson.

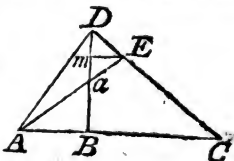
Put $Aa = a$, $BC = b$, and $DA = d$. Draw mE parallel to AB , and call it x .

Per similar Δs $x : d :: b : \frac{bd}{x} =$

$$CD, \text{ and } x : d :: \frac{bd}{x} : \frac{bdd}{xx} =$$

$AC;$

$$\text{Then by 47 E. I, } \sqrt{\frac{b^2 d^4 - b^2 d^2 x^2}{x^4}} = AD.$$



Also

* II. QUESTION 144.

$$\text{As } 10 (= 7 + 3) : 365 :: \begin{cases} 7 : 7 \times 365 = 255.5, \\ 3 : 3 \times 365 = 109.5. \end{cases}$$

G g

Also $\frac{bdd - bxx}{xx} = AB$, \therefore per similar Δ s, $\frac{bdd - bxx}{xx}$

$$: a :: x : \frac{ax^3}{bdd - bxx} = Ea.$$

By 47 Eucl. 1, we have

$$\sqrt{\frac{aax^6 - 2baax^5 + bbaa^2x^4 + 2bddaax^3 - 2bddaa^2x^2 + bbd^6aa}{bdd^4 - 2bdddx + bbx^4}} = AD.$$

Which being made equal to the above value of it, and the equation reduced, we have

$$aax^{10} - 2baax^9 + bbaa^2x^8 - bddx^7 + 2bddaax^6$$

$$+ bdd^2x^5 - b^2d^6x^4 + 3b^4d^4d^6x^2 = b^4d^8.$$

Or in numbers, $x^{10} - 25.6x^9 + 105.1932x^8 + 640x^7 + 4349.031x^6 - 64906.085x^4 + 18016295.945649x^2 = 150135799.54708$, &c.

Which solved, is $x = 4$ leagues.

Therefore $AD = 12$ leag. = dist. ship A from D ,
 $BD = 9.6$ dist. ship B from D ,
 $BAA = 30^\circ 28' 53''$ the course of ship A .*

The proposer of the question, Mr. Fearnside, gives the course the ship took N.E. by N. $\frac{1}{4} 35^\circ 39' N$. but the answer above agrees exactly with him as to the scheme and method.

IV. QUES-

* III. QUESTION 145.

To render this question and its solution plain, it may be remarked that, In the triangle ADC , right-angled at D , having drawn AE and the perpendicular DB , there are given $Aa = 8\frac{1}{2}$, $BG = 12.8$, and $DE = 5$; to find the other parts.

* IV. QUESTION 146 answer'd by Mr. Tho. Grant.

There is given $x^x = 123456789 = a$. Quere x ?

Let n be assum'd near the root x , $z =$ their difference, and $ln =$ the hyperbolic logarithm of n : Then $n \pm z = x$, and (per fluxions) its hyp. log. $= ln \pm \frac{z}{n} - \frac{z^2}{2n^2} \pm \frac{z^3}{3n^3} - \frac{z^4}{4n^4} \pm \frac{z^5}{5n^5}$, &c. this multiplied by $n \pm z$ gives $nln \pm z \pm zln + \frac{z^2}{2n} \mp \frac{z^3}{6n^2} + \frac{z^4}{12n^3} \mp \frac{z^5}{20n^4}$, &c. $= la =$ the hyperb. log. of a .

Put $s = 1 + ln$, $d =$ the difference between la and nln ; then $sz \pm \frac{z^2}{2n} - \frac{z^3}{6n^2} \pm \frac{z^4}{12n^3} - \frac{z^5}{20n^4}$, &c. $= d$; which by inverting the series becomes $z = \frac{1}{s}d \mp \frac{1}{2ns^3}d^2 + \frac{3+s}{6n^2s^5}d^3 \mp \frac{15+10s+2s^2}{24n^3s^7}d^4 + \frac{105+165s+60s^2+6s^3}{120n^4s^9}d^5$, &c. this wrought in numbers gives $n \pm z = x = 8.6400268$.

N. B. The above method will find x to any degree of accuracy by only assuming n nearly $=$ to x , and even without that if the logarithm of a and n be made to a sufficient number of places.

V. QUES-

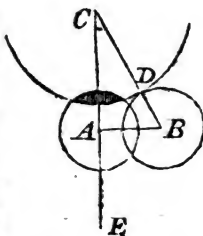
* IV. QUESTION 146.

Though the above be a very complete and masterly solution, the method of trial-and-error would sooner approximate to the value of the root.

* V. QUESTION 147 answer'd by Mr. W. Grimmet.

Let $a = AC$ the base, $b = AC + AB$ the sum of the base and perpendicular, $c = AC + BC$ the sum of the base and hypotenuse: Then $b - a =$ the perpendicular; and, per 47 Eucl. I, $\sqrt{2aa - 2ba + bb} = CB$ the hypotenuse. Therefore

$\sqrt{2aa - 2ba + bb} + a = c$: which equation solved, a will be found = $54'4985$ the base, and perpendicular = $28'5015$, to which add 4 gives the moon's diameter = $32'5015$; and if from the hypotenuse = $61'5015$, be subtracted the moon's semidiameter, it leaves $CD = 45'2508 =$ semidiameter of the earth's shadow; also from the hypotenuse subtract the base, remains the opaque part of the moon = $7'0028 = 2$ digits $35' 7''$.



VI. QUES-

* V QUESTION 147.

This question is the same as, In a right-angled triangle, having given the two sums of the base and hypotenuse, and base and perpendicular; to determine the triangle. Of which this is the

Construction.

The difference between the two given sums will evidently be equal to the difference between the hypotenuse and the perpendicular: Take EA equal to this difference, and $EAC =$ a mean proportional between EA and the greater of the above two sums; and AC will be the base of the triangle. Then the hypotenuse and perpendicular are easily found by subtraction.

Demonstration.

Since $CE^2 = (CA + AE)^2 = CA^2 + 2CA \times AE + AE^2$
by Eucl. II. 4,

And $AE = CB - BA$ by the construction,

Also $AE^2 = CB^2 - 2CB \times BA + BA^2$ by Eucl. II. 7,

We have $CE^2 = CA^2 + 2CA \times CB - 2CA \times AB + CB^2$
 $- 2CB \times BA + BA^2$;

Again $CB^2 = CA^2 + BA^2$ by Eucl. I. 47,

Therefore $CE^2 = 2CB^2 + 2CB \times CA - 2CB \times BA - 2CA \times AB$
 $= \frac{CB + CA}{2} \times \frac{CB - BA}{2}$ (by Eucl. II. 1.)
 $= \frac{CB + CA}{2} \times 2AE.$ Q.E.D.

* VI. QUESTION 148 answer'd by Mr. John Fearnside.

Two bodies gravitating towards each other, the distances of the common center of attraction, are directly as the quantities of matter in the bodies: Whence the quantity of matter in the earth being, according to Sir Isaac Newton, to that of the moon, as 39'778 to 1. And the mean distance of the earth and moon = 1271018757 English feet, the distance required from the earth 215882 miles, and from the moon 59018 miles.

The moon is at her nearest distance from the earth, when she transits her perigæon at the moment of her being in opposition to the sun; and the earth in aphelium; which happens very nearly, (viz.)

	da.	h.	'	"
The moon in perig. 1730, june	18	19	36	31
Full moon — — —	18	21	3	31
Earth in aphelium — — —	18	23	51	0

Mr. W. Grimmet, who has answer'd this question, observes that there may be different answers to the question, according to the authors made use of for the distances and magnitudes. Some few of the answers follow:

	From earth.	From moon.	Eng. miles.
Mr. Beacbam	218985	5688	Mr. Mason 228302 5779
Mr. Grimmet	204395	7669	Mr. Grant 1090685659 and
Mr. Bulman	202143	4166	27414940 Paris feet.
Mr. Hawksfworth	231059	4955	

VII. QUES-

* VI. QUESTION 148.

The above answers to this question are all wrong. For, the gravitation towards any body being as its quantity of matter directly, and square of its distance inversely; if e to m denote the proportion of the quantity of matter in the earth to that in the moon, d the distance of their centers, and x and z the respective distances, from their centers, of a body placed between them; then the gravitation

towards the earth will be, as $\frac{e}{x^2}$, and towards the moon as $\frac{m}{z^2}$:

that the body be at rest between them then, or gravitate equally

towards them, we must make $\frac{e}{x^2} = \frac{m}{z^2}$, and hence $\sqrt{e} : \sqrt{m}$

:: $x : z$; that is, the distances from them must be as the roots of the masses, which in the present case are nearly as $6\frac{1}{4}$ to 1.

$$\text{Hence } \sqrt{e} + \sqrt{m} : d (=x+z) :: \left\{ \begin{array}{l} \sqrt{e} : \frac{d\sqrt{e}}{\sqrt{e} + \sqrt{m}} = x, \\ \sqrt{m} : \frac{d\sqrt{m}}{\sqrt{e} + \sqrt{m}} = z. \end{array} \right.$$

G g 31

* VII. QUESTION 149 answer'd by Capt. Wm. Scarth.

The latitude $26^{\circ} 33' N.$ the hour $4h. 13' 48''$.

† VIII. QUESTION 150 answer'd by Mr. Geo. Anderson.

Put $AD = b$, $BD = d$, the latus rectum $= l$, and $x = bE$?

Per conics, $l : d + x ::$

$$d - x : \frac{dd - xx}{l} = bS,$$

By 35 Eucl. 1, $\frac{2ddx - 2x^3}{l}$

= area of the parallel.

This in fluxions,

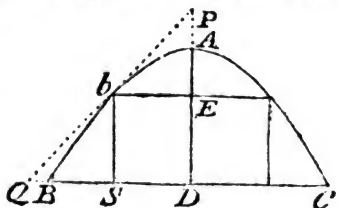
$$\frac{2dd\dot{x} - 6x^2\dot{x}}{l} = 0,$$

$$dd = 3xx,$$

Hence $x = d\sqrt{\frac{1}{3}} = 20.7846$, and $\frac{2ddx - 2x^3}{l} = 1108.512$,

&c. square chains = 110a. 3r. 16p.

IX. QUES-



* VII. QUESTION 149.

Here are given $Z\odot$ the co-altitude $= 57^{\circ}$ (see the spherical triangle in page 227) $P\odot$ the co-declination $= 66^{\circ} 31'$, and ZP = the angle P .

Put a = s. altitude = cof. $Z\odot$,

d = s. declination = cof. $P\odot$,

c = its cof. = s. $P\odot$,

and z = cof. PZ or $\angle P$.

Then, per spherics $\frac{a - dz}{c\sqrt{1 - z^2}} = z$;

Hence $ccz^4 - cczz + ddzz - 1adz = -aa$; the root of which equation will answer the question.

† VIII. QUESTION 150.

If to the point b there be drawn a tangent meeting the abscissa and ordinate, produced, in P and Q : Then, in all curves that are concave towards their axes, it is $QS = SD$, and therefore $DE = EP$ by similar triangles; but, by the nature of the parabola, AE is $= \frac{1}{2}EP$; therefore $AE = \frac{1}{2}ED$ or $= \frac{1}{2}AD$; and consequently the height of the parallelogram $ED = \frac{1}{2}AD$. Also, since the ordinates of a parabola are as the square roots of their abscissas, and the abscissas being as 3 to 1, therefore the ordinates are as $\sqrt{3}$ to 1.

So that $AD : AE :: 3 : 1$,

and $BD : bE :: \sqrt{3} : 1$.

* IX. QUESTION 151 *answer'd.*

$$\left. \begin{array}{l} a = 85'379 \\ e = 79'899 \end{array} \right\} \text{their ages.}$$

The PRIZE QUESTION answer'd.

This question may admit of some differences in the answer as the proportions vary in authors. I shall therefore first give you the proposer Mr. *Tho. Pointin's* answer.

The distance of the earth and ☉ 80015040 miles.

From the center of ☉ to ☽ — 236350

From center ☉ to ☽ surface — 80251390

The weight of a body at the ☉ and ☽ as 1 to 516; the force of the ☉ at ☽ 516 — 000284: = 515716 × 22650 = 1168096 the weight at the ☽; by which the prime cost is 2*l.* per hundred: for 515716 × 100 × 22650 = 116809674 2336193'48 (2. Let 2*a* = *A's* cash, 4*a* = *B's*, and 16*a*⁴ + 8*a*³ + *a* = *C's* stock. Therefore 16*a*⁴ + 8*a*³ + 5*a* = sum. *A* = 6 price 12 lib. *B* 150, *C* 2250, and total stock = 22650. The total gain 2290893, of which *A's* gain = 606'8592 lib. *B's* = 14564'6208, *C's* = 2275722: the weight at the earth and Jupiter as 1 to 20108. So the weight will be 4554462 = 2033 tun 4 cwt. 94 lb. Mr. *Grimmet*, Mr. *Sidebottom*, Mr. *Bullman*, Mr. *Fearnside*, Mr. *Pilgrim*, and some others, make the weight at the moon 567 tuns, at Jupiter 2210 tuns. Mr. *Richards*, Mr. *Fairchild*, Mr.

* IX QUESTION 151.

Of the two given equations $\left\{ \begin{array}{l} a^3e + a^2e^3 = b \\ a^3e^2 + ae^3 = c \end{array} \right\}$, the latter being multiplied by *a*, and the former taken from the product, there remains $e^2a^4 - ea^3 = ca - b$; hence $e = \frac{a \pm \sqrt{a^2 + 4ac - 4b}}{2a^2}$;

this being substituted in one of the original equations, there will result an equation with only one letter in it, and which from it may be found.

Otherwise.

Take two near values of *a* and *e*, as 85 and 80, and call the differences *x* and *z*; then *a* = 85 + *x*, and *e* = 80 - *z*: substitute these in the two original equations, neglecting all the terms which rise to above two dimensions, and there will result two quadratic equations, from which *x* and *z* may be found.

Mr. Hale, Mr. Lowe, Mr. Mason, Mr. Grant, and some others, 386 tun at D; and 15071 at Jupiter; several of whom have wrought this question very curiously, and in an algebraic method, but my room will not permit inserting them.

The prize of 10 diaries fell to the lot of Mr. J. Pilgrim.

Of the Eclipses in 1731.

To the inhabitants of this terraqueous globe this year will happen four eclipses: Twice will the moon's opaque body interpose between the sun and us, and hinder part of his rays falling on the earth: And twice will the earth come between and hinder the sun's giving the moon her borrow'd light.

1. Moon eclipsed on Wednesday the 9th of June, at 3 quarters past 1 in the morning, about 2 digits north.

Computed by	Begin h. m.	Midd.	End.	Dur.	Dig.
By Astronom. Carol. Coventry	0 59	1 43	11 27	1 27	2 0
Mr. Chattock, London —	1 1	1 54	2 46	1 44	2 44
Mr. Leadbetter, London —	1 12	1 54	2 37	1 25	1 52
Mr. Turner — — —	0 59	1 45	2 31	1 32	2 2
Mr. Pilgrim — — —	1 4	1 49	2 35	1 31	1 59
Mr. Wm. Brown, Bridgenorth	0 55	1 39	2 22	1 27	2 0
Mr. J. Bulman, Lewisham in Kent	1 5	1 49	2 33	1 28	2 2
Mr. J. Fearnside — — —	0 34	1 19	2 4	1 30	2 4
Mr. Oats, Falmouth — —	0 36	1 20	2 4	1 28	2 9
Mr. J. Newton, Melton Moberry	1 3	1 50	2 37	1 33	2 15

2. Sun eclipsed the 23d of June, at 1 min. past 6 in the morning, but invisible, because the moon having south latitude, her parallax depresses her too much in our northern latitude.

3. Moon eclipsed the 2d of December, at 36 min. past 11 in the morning, and consequently invisible to us.

4. Sun eclipsed the 17th of December, at 57 min. past 12 at night, and therefore invisible to us.

New Questions.

I. QUESTION 151, by Mr. Tho. Williams.

Far in the west, I know not where,
But somewhere on this earthly sphere,
A lofty pillar stands erected,
From the top of which a ball projected,
With a direction thirty-one
Degrees above the horizon,
Did, in nine seconds ten thirds space,
Fall just two thousand feet from its base.

Artists, this pillar's height explain
Above the horizontal plain.

II. QUESTION 152, by Mr. Geo. Anderson.

Mr. Euclid Speidell, in his Geometrical Extractions, p. 59, says, If upon C , one end of the base CA , of the triangle ABC , you raise a perpendicular CD , equal to the perpendicular BP , let fall from B to CA , and join DA ; that the right line GE bisecting the angle ACD , being produced, shall cut DA in such a point F through which, if the right line GH be drawn parallel to the base CA , the part GH intercepted between the two sides BC and BA , shall be the side of the square made in the aforesaid triangle.

Quere, The geometrical demonstration?

III. QUESTION 154, by Mr. John Turner.

To Newton's genius, and immortal name,
And those whose works in the records of fame
Like his will ever stand, what praise we owe;
Since 'tis from their discoveries we know
The various changes of the wand'ring moon,
And whence proceed th' eclipses of the sun;
What force the planets in their orbs retain,
Which move so swiftly thro' th' etherial plain;
What makes the sea retreat, and what advance,
Varieties too regular for chance;
How vapours hanging on the lofty hills,
In breezes sigh, or weep in warbling rills;
Whence infant winds their tender pinions try,
And tornado's bluster in the sky,
With some rais'd higher first in secret streams,
Owe the reflected points of bounding beams;

Others,

Others, whose parts a slight contexture show,
Sink hov'ring thro' the air in fleecy snow;
And others laid in trains, that kindled fly,
In harmless fire by night, about the sky.
May we their bright examples emulate,
And mathematic knowledge propagate;
To answer which intent, ye sons of art,
Resolve the questions which I here impart.

Let a stone be whirl'd round in a sling, whose length is equal to 33 inches, performing each revolution in the time of two-thirds of one second. Required the ratio of the centrifugal force to the weight of the stone? That is, the ratio of the tension of the string whirled round in this manner, to the tension arising from the force of the same weight hanging freely, and without motion?

IV. QUESTION 155, by the same.

Suppose the earth's radius = 6982000 yards, and that there is a mountain upon its superficies of such an height, that a clock when on the earth's surface, shall point out equal time; but when carried to the top of the mountain, shall be so retarded as to err 2 minutes every day. 'Tis required to give that mountain's elevation.

V. QUESTION 156, by Mr. William Grimell.

Required the greatest parallelogram that can be inscribed in an ellipsis, whose transverse is 10, and conjugate 8: And supposing the ellipsis to revolve upon its transverse axis, Required also the greatest cylinder that can be inscribed in the spheroid that's generated by the revolving ellipsis? And to shew the analytical investigation of the same?

VI. QUESTION 157, by Mr. Christ. Hale.

Unto a pleasant bower I took my way,
One evening late, it was the ninth of May;
Viewing the heav'ns, the works of mighty Jove,
Each glitt'ring star, in order as they move:
When one amongst the rest I did espy;
Its rays of light came pointing to my eye.
Its name and latitude I fain would know;
From what is given here below.

The latitude of the place $29^{\circ} 22'$. The altitude is equal to the hour from noon, and equal to the azimuth.

VII. QUES.

VII. QUESTION 158 *by Mr. John Fearnside.*

A garden lies on Ebor's fertile plains,
 Where with magnificence fair Flora reigns:
 She decks the flowers with most auspicious hue,
 The rose vermilion, violet with blue.
 Three lofty walls surround the beauteous place,
 A curious statue each of which does grace:
 Erect they stand, and view th' adjacent plain,
 Admir'd and seen by every neighb'ring swain.
 Bacchus on this, on that Apollo stands;
 Hermes (the messenger of Jove's commands)
 Upon the third is plac'd, whose length, in feet,
 Is known three hundred sixty-three compleat.
 With artful fancy, walks are form'd therein,
 And various windings beautify the scene.
 Three walks from the three effigies are made,
 Where stately cedars yield a pleasant shade;
 The zephyrs revel in the sportive boughs,
 And kindly Sol's meridian heat subdues.

The walk from Hermes was to Bacchus known,
 In feet and parts, as in the margin's shewn: (216'4074
 And from Apollo to the other two
 Is also given, as may be seen below.

Observe the walk between the unknown walls
 At angles right, to one exactly falls, (* 559
 Which wall subtends an angle given, * from whence
 The garden's area, and the walks true lengths,
 Ladies, to whom our annual praise is due,
 Vouchsafe to tell? For nothing's hid from you.

From Apollo to { Bacchus 192'1306 feet,
 Hermes 209'694.

VIII. QUESTION 159, *by the same.*

What time of the day is the hottest at York on the 8th of June, supposing it to be as the sine of the sun's altitude, and the time of his continuance above the horizon?

IX. QUESTION 160, *by Mr. Chr. Mason.*

In verdant meads, where I last spring survey'd,
 The flowing streams did o'er the banks invade,
 And forc'd me thence new methods to contrive:
 So cowards fly, when seeming dangers drive.

I view'd

I view'd some marks where on dry ground I stood,
 And then despis'd the proud insulting flood.
 From north to south I'd chains just twenty-three,
 Then west two marks I in one line did see.
 Unto the first I could no measure take;
 But 'tween the two I 40 chains did make.
 Then to my northern station I apply'd,
 Where the two western marks I plain descry'd:
 Thrice ten degrees the angle made from thence,
 By which you now may find this consequence:
 And in your next the distances define,
 From those two marks to th' ends of the first line.

X. QUESTION 161, by Mr. Tho. Pointin.

In th' Atlantic ocean an island is found,
 Neither oblong nor square, but perfectly round;
 In the center of which a tower's erected,
 From whence with much ease their foes are detected:
 For if Neptune but smile, and the sky be serene,
 Four leagues * from the shore is the horizon seen,
 We being at anchor, o'er the top o'th' mast, }
 From the top o'th' tower a line being past, }
 Did bound the utmost stretch of sight at last.
 From thence we set sail, and I'll tell you in short,
 The distance † we ran, to arrive at our port:
 And also our course ‡ as corrected at noon,
 Perform'd with great care by the height of the sun:
 Which, to my surprize, neither higher nor lower,
 Was cut in two halves by the fore-mention'd tower.
 The height of our mast from the water's here shown,
 And whatever else is most fit to be known §;
 Which being suppos'd, what I want to be found,
 Is the tower's just height, and land's compass round.
 Besides, when you're got in this figuring strain,
 Let's know the square miles the whole doth contain.

* Note $69\frac{1}{2}$ miles to a degree, three of which are a league.

† Our distance $\frac{2}{3}$ of a degree.

‡ Our course N. by E. $2^{\circ} 45'$ E. or 14° from N. to E.

§ The height of the mast from the water 45 feet. Lat. $64^{\circ} 20'$ N. of the tower $63^{\circ} 50'$. The ship's distance from the shore is 1.263244 leagues.

XI. QUESTION 162, by Mr. C. Mason.

It is required to find two such numbers, viz. *A* and *B*,
 that the sum of the aliquot parts in *A* may be equal to $\frac{2}{3}$ of
B, and the sum of the aliquot parts in *B* equal to $\frac{2}{3}$ of *A*.

The

The PRIZE QUESTION, by Mr. Pointin.

From noisy courts, and from the jangling bar,
 Where lawyers tongues proclaim litigious war,
 My friend withdraws, to his paternal seat ;
 A golden mean betwixt too small, too great :
 Where nature's wants still meet a full supply,
 With ample room for christian charity :
 For great estates but foster up and feed
 Those vices which their own excesses breed.

Here Strephon liv'd in plenty, free from cares,
 And blest contentment crown the circling years :
 Vice here no favour found ; 'twas virtue's court,
 Where good and wife did ev'ry day resort.
 A foe to ignorance, a friend to truth,
 A prop to age, a star to wand'ring youth :
 To th' fatherless, a gracious father was,
 And ne'er forsook the mournful widow's cause.
 A friend to all ; for all by him were fed,
 The rich with wisdom, and the poor with bread.
 Heav'n markt the man, from peaceful realms above,
 Saw all his acts spring from the source of love,
 To that great God, from whose refulgent throne
 Whate'er of good we have, is shower'd down,
 A faithful steward of his stock in trust,
 And to reward him heaven thought it just,
 To all the good he had bestow'd before,
 To add yet one, one precious blessing more ;
 A blessing, which to mortals here below
 Is seldom sent, and none but fav'rites know,
 A virtuous wife ! To whose capacious mind
 Both wit and beauty friendly nature join'd :
 And as their years, so did their loves increase ;
 They liv'd contented, and they dy'd in peace.
 Full well they knew, death but remov'd their seat,
 Did not extinguish life, but change its state ;
 Where is display'd (O ravishing surprize !)
 Rich scenes of bliss, and glory in the skies :
 Two sons, their virtue share, which at one birth
 Their pious mother with small pain brought forth.
 His lands he gave, by good advice in law,
 To both so sure, that it admits no flaw.
 The cash and goods your judgment must decide ;
 For so by will it's plainly specify'd.
 By what below is in few words declar'd,
 The way you'll find by which it must be shar'd.

Diary Math.

II h

Call

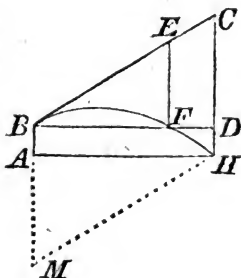
Call the eldest b , the youngest c : Then let $b + c = a$, then $c + \frac{a}{5} = b$ per father's will: D hath a yearly income or annuity that will fall to him seven years hence, and thence to continue seven years; which sold at 6 per cent. = $\sqrt[3]{ab}$, and the rent = $\sqrt[3]{ca}$. Quere a ?

1732.

Questions answered.

I. QUESTION 151 answer'd by Mr. Rob. Fearnside.

IN the same time the ball describes BE , another body let fall from E wou'd fall the space EF , and consequently in $9'' 10'''$ time, when the ball is at H , an heavy body will describe $CH = 1351.4$ feet. Then as cosine 31° : $BD = 2000$ feet :: sine 31° : $CD = 1201.7$ feet; consequently the pillar's height = $CH - CD = 149.72$ feet = AB .



The same answer'd by Mr. Wm. Grimmett.

Let BA represent the pillar, AH the distance the ball falls from the base of the pillar equal to 2000 feet. Let CH be perpendicular to AH ; BC the line in which the projectile is directed, in which it would move equal spaces in equal times, were it not deflected downwards by the force of gravity. 'Tis known all projectiles will (rejecting the resistance of the medium) describe parabolas: therefore BC is the tangent of that parabola, BD is parallel to AH the horizon: draw MH parallel and equal to BC : consequently MH is an ordinate to the diameter BM . Then in the right-angled triangle BDC there is sufficient given to find the sides. And since the velocities of all projectiles in the several points

points of the curve, are as the lengths of the tangents to the parabola in those points, intercepted between any two diameters; therefore $BC = 2333'33$ divided by $9\frac{1}{2}$ (= number of seconds the ball was in motion) gives $254'54$ the velocity in a second; and the square of the velocity divided by $16\frac{1}{2}$ feet, the space a body describes in a second by gravity, gives the parameter to the diameter BA . That is (per conics) the rectangle under the intercepted part of the diameter taken from its origin B towards A , and the parameter, is = the square of its correspondent semiordinate: whence the parameter is = $4028'43$; and the square of MH divided by the parameter, gives $BM = 1351'5$. But $BM - AM = BA = 149'5$ the height of the pillar.

* II. QUESTION 152 answer'd.

Produce HG to L , and draw Fm and GK parallel to PB .

(1) $BP : BN :: CP : GN$ } per figure.
(2) $BP : BN :: PA : NH$ }

Per 11.5 Euc. (3) $CP : GN :: PA : NH$.

Per altern. (4) $CP : PA :: GN : NH$.

Per comp. (5) $CA : PA :: GH : NH$.

Per altern. (6) $CA : GH :: PA : NH$.

Per steps 2.6. (7) $BP : BN :: CA : GH$.

But the $\angle MCF$ per hypothesis is $\frac{1}{2}$ a right angle, and CMF is a right angle, and consequently CEM is $\frac{1}{2}$ a right angle, and therefore CM or $LF = FM = GK$. Moreover $DC = BP$ per hypothesis, and $DL = BN$ per construction. Therefore

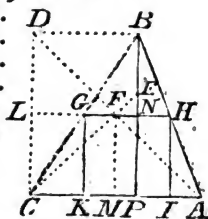
Per. step 7. (8) $DC : DL :: CA : GH$.

But per fig. (9) $DC : DL :: CA : LF$.

Then per } (10) $CA : GH :: CA : LF$.

11 E. 5. } Therefore $GH = LF = GK$. Q. E. D.

Answer'd.



* II. QUESTION 152.

This construction may be otherwise demonstrated thus:

As DC or $BP : CA :: DF : FA$ (Eucl. VI. 3) :: $DL : LG$ or GK (Eucl. VI. 2), but $BP : CA :: BN$ or $DL : GH$; $\therefore GK = GH$.

Why the proposer of the question calls *Speidell* by the name of *Euclid*, I know not. His name was *John*, as appears by the book, which was published in the year 1617.

H h 2

Answer'd by Mr. Will. Grimmer.

The geometrical demonstration of this problem may be easily seen from the proposer's own scheme, without any previous construction, (viz.) Since there cannot be but one square inscribed in that position, and that KC is equal to KF each subtending an angle of 45° (per prob.); therefore if we prove that $KF = GH$ universally, it is demonstrated; for KC is equal to GH (which is supposed to be a side of a square.)

Demonstration.

From 37 Euc. 1, the triangles DCB and DAB are equal; and if an infinite number of right lines as KH be drawn parallel to the common base DB , the parts of those lines which are intercepted by the respective sides of the triangles, will also be equal, that is $KG = FH$; which is Cavalierius's method of proving the triangles to be equal (which is the method of indivisibles;) therefore if to both be added or subtracted (as the case requires) $GF, KF = GH$. Q. E. D.

III. QUESTION 154 *answered by the proposer.*

As 113 : 355 :: 66 : 207.35 inches, the arch described in $\frac{1}{4}$ of 1"; and 207.35 squared and divided by 66, the double length of the sling, is = 651.03 the centrifugal force. But the descent of a heavy body in $\frac{1}{4}$ of 1" is = 86.208 inches: whence the centrifugal force is to the force of gravity as 651.4 to 85.7 or as 7.6 to 1.

The same answer'd by Mr. John Ommanney.

The stone, if let fall out of the sling when at rest, by the force of gravity would descend $85\frac{1}{4}$ inches; which call b . Now let F be the force of the stone or tension of the string when at rest; and E that when in motion. The lengths gone over are always proportional to the force impressed. Therefore $F : E :: b : \frac{Eb}{F}$ the space descended through with the force E in the same time. Let c = the circumference of the sling = 287.344, and d = diameter = 66; then, by Sir Isaac Newton, $\frac{rc}{d} = \frac{Eb}{F}$. Whence $F : E :: db : cc$. That is as 5659.5 to 42991.9, or as 1 to 7.596. Q. E. I.

IV. QUES-

* IV. QUESTION 155 *answer'd.*

The number of oscillations in each place being equal, will be as the time in one place to the time in the other, viz. as 1440 to 1442. Let n = earth's radius, and a = radius and the height of the mountain together; the force of gravity being inversely as the square of the distance from the center, we shall have $1442n = 1440a$, and $\frac{1442n}{1440} = 6991698 = a$; from which subtracting the radius of the earth = 6982000, remains the mountain's height = 9698 yards = $5\frac{1}{2}$ miles 18 yards.

Answer'd

* IV. QUESTION 155.

Universally, the lengths of pendulums being directly as the force of gravity drawn into the squares of the times of vibration, and the pendulum being of the same length in both cases, we shall have $ft^2 = FT^2$, putting f and t for the force of gravity and time of vibration at the earth's surface, and F and T for the same at the top of the hill. But the force of gravity is inversely as the square of the distance from the earth's center; that is f is as $\frac{1}{r^2}$,

and F as $\frac{1}{(r+x)^2}$, putting r for the earth's radius, and x for the

height of the hill; then the above equation becomes $\frac{t^2}{r^2} = \frac{T^2}{(r+x)^2}$,

or $\frac{t}{r} = \frac{T}{r+x}$. Again the time of a vibration being inversely as the number of vibrations in a given time, and the number of vibrations being as 1440 to 1438; the same equation will become $\frac{1}{1440r} = \frac{1}{1438 \times r+x}$: Hence $x = \frac{2r}{1438} = \frac{r}{719} = 9710.7$

yards = the height of the mountain required.

Corollary.

Hence it appears in general, that if t be the time lost in the time T ; then 24 hrs. — $t : T :: r : x$; or, because 24 hours — t is nearly = 24 hrs. it will be nearly as 24 hrs : $T :: r : x$; that is, the whole time is to the time lost, as the radius of the earth to the height of the hill.

Answer'd by Mr. Geo. Anderfon.

The length of a pendulum vibrating feconds on the mountain's top will be = 39'09 inches; therefore by Huygen's proportions the space defcended in a fecond of time on the top of the mountain will be 192'9009 inches; and the fpace defcended in a vibration of the clock is 193'4437 inches: And the gravity being defin'd by the fpace pals'd over in a fecond of time. From corol. 2 prop. 5 theor. Principia Philofophiæ; put r = earth's radius, x = mountain's height.

$$r^2 + 2xr + x^2 : r^2 :: 193'44 : 192'9.$$

And therefore $x = .0014059r = 353375'7768$ inches or 9815'99 yards or 5'5773 miles.

V. QUESTION 156 *answer'd by Mr. John Turner.*

Let $SD = t = 5$; $BS = c = 4$; $St = a$; $Dt = t + a$; and $At = t - a$. Then we have

$$\text{As } tt : cc :: tt - aa \\ : \frac{cc tt - tt aa}{tt} = \text{square of}$$

$$tx. \text{ Ergo } tx = \sqrt{\frac{cc tt - cc aa}{tt}}$$

$$\text{and } Cx = \sqrt{\frac{4cc tt - 4cc aa}{tt}}.$$

This multiplied by $vt = 2a$, makes the area of the rect-

$$\text{angle } ymx = 2a \sqrt{\frac{4cc tt - 4cc aa}{tt}} = \sqrt{\frac{16cc tt aa - 16cc a^4}{tt}};$$

But this, by the question, must be a maximum; therefore the fluxion of t which is $\frac{32cc tt aa - 64cc a^3 a}{2\sqrt{16cc tt aa - 16cc a^4}} = 0$. From

hence $64cc aa = 32cc tt$: And $a = t\sqrt{\frac{1}{2}} = 3'535$: And $2a = vt$ is = 7'070, and ym or $xG = 5'657$. Again for the greatest cylinder, fupposing it to revolve about the tranfverfe axis, we found above $Cx = \sqrt{\frac{4cc tt - 4cc aa}{tt}}$.

Ergo Cx squared is = $\frac{4cc tt - 4cc aa}{tt}$; this multiplied by $vt = 2a$ must, per question, be a maximum. The fluxion of $\frac{8cc tt a - 8cc a^3}{tt}$ is $8cc tt \dot{a} - 24cc a \dot{a} = 0$. Hence

we have by divifion and tranfpofition $a = t\sqrt{\frac{1}{2}} = 2'887$: And $vt = 2a = 5'774$ the cylinder's altitude, and xG or my the diameter of the bafe = 6'532. Q.E.I.

The

* *The proposer's answer.*

Put $d = AD$, $c = nB$, $x = Dv$, $y = yv$.

Then $2y$ and $d - 2x$ the sides of the parallelogram; the rectangle of which is $2yd - 4xy$, the fluxion of which, if a maximum, is $2d\dot{y} - 4x\dot{y} - 4xy = 0$, $= d\dot{y} - 2x\dot{y} - 2xy = 0$.

By the property of the ellipse $dd : cc :: dx - xx : yy$.

$$\text{Ergo } y = \sqrt{\frac{dccc - ccxx}{dd}}.$$

$$\text{In fluxions } \dot{y} = \frac{dccc - 2ccx\dot{x}}{2d\sqrt{dccc - ccxx}}. \text{ Which substituted in}$$

the

* V QUESTION 156.

In the solution of question 74, at page 181, it is proved that $CE = CA\sqrt{\frac{1}{2}}$, [see the fig. to that solution] and $EF = CD\sqrt{\frac{2}{3}}$; CE being half the height, and EF half the diameter of the cylinder, when CA is the semitransverse, and CD the semiconjugate axe.

Again, supposing CE and EF to be the halves of the length and breadth of the greatest inscribed parallelogram, by page 201 Simpson's Geom. 2d edit. CE is $= \frac{1}{2}CT$, and $EF = \frac{1}{2}CK$; but, by the nature of the ellipse, $CE : CA :: CA : CT$ or $2CE$; hence $CE = CA\sqrt{\frac{1}{2}}$. And in like manner $EF = CD\sqrt{\frac{1}{2}}$.

Corollary.

Hence, if t and c denote the whole transverse and conjugate axes,

Then $t\sqrt{\frac{1}{2}}$ = length of the greatest rectangle,

$c\sqrt{\frac{1}{2}}$ = breadth of the same,

$\frac{1}{2}ct$ = area of the same.

And $t\sqrt{\frac{1}{3}}$ = length of the greatest cylinder,

$c\sqrt{\frac{2}{3}}$ = diameter of it,

$$\frac{2c^2t\pi}{3\sqrt{3}} = \text{content of it, putting } \pi = 3.14159 \text{ \&c.}$$

the former, we have $\frac{d c c \dot{x} - 2 c c x \dot{x}}{\sqrt{d c c x - c c x x}} = 2 \dot{x} \sqrt{\frac{d c c x - c c x x}{d d}}$

$- x \times \frac{d c c \dot{x} - 2 c c x \dot{x}}{d \sqrt{d c c x - c c x x}} = 0$. Which reduced, then $x x$

$- d x + d d = -\frac{1}{2} d d$.

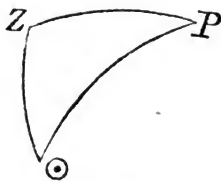
Hence $x = \frac{1}{2} d - \frac{d}{\sqrt{8}} = 1.4645 = D v$: from whence $m x$ will be found $= 7.071$, and $m y = 5.6568$: and the area of the greatest parallelogram $= 39.999999$. Q.E.I.

VI. QUESTION 157 answer'd by Mr. Geo. Anderson.

In contemplating on the solution of the 159th question, I hit upon the following lemma, which I find to be so useful in solving astronomical questions of that kind, that I believe there can no such question be proposed, but it will be found a useful instrument in solving it.

In the spherical triangle let P be the north pole, Z the zenith, \odot the place of the sun: And

Put $\begin{cases} 1 = \text{radius,} \\ a = \text{tangent of } ZP, \\ s = \text{coline of } ZP, \\ d = \text{right line } \odot P, \\ e = \text{coline of } \odot P, \\ g = \text{coline of } \odot Z, \\ x = \text{coline of } \odot PZ. \end{cases}$



LEMMA.

$$e + d a x \times s = g.$$

Corollary.

In question 157 there is given the latitude of the place, and the altitude equal to the hour from noon and to the azimuth, to find the latitude of the star (or declination with respect to the sun); therefore in the room of g in the lemma put $\sqrt{1 - x x}$ ($=$ sine of the hour) and there will be had $e + d a x \times s = \sqrt{1 - x x}$, from the equality of the hour and altitude. And now to answer the other parts of the question, because the azimuth is equal to the hour, therefore the same x still represents the coline of the angle $\odot Z P$, and the theorem must be so transposed that $\odot Z P$ may be the angle contain'd: wherefore since $\angle P$ is one of the containing sides of the angle $\odot Z P$, as well as of the angle $\odot P Z$, therefore

therefore a and s may still retain their former office, but for d must be wrote $\sqrt{1-gg}$, and for e put g , and for g write e , and for e put x , and then the lemma will stand thus, $x + ax\sqrt{1-gg} \times s = e$. But becaufe $\sqrt{1-gg} = x$, the theorem will be $sx + saxe = e$; therefore from the two equations $e + ax\sqrt{1-ee} \times s = \sqrt{1-xx}$, and $x + saxe = e$, exterminate e you'll have this equation $s^8 a^8 x^{12} + 4s^8 a^7 x^{11} + 8s^8 a^6 x^{10} + 12s^8 a^5 x^9 + 14s^8 a^4 x^8 - 4s^4 a^3 x^7 - 4s^6 a^4 x^6 + 4s^4 a^3 x^5 - 4s^6 a^2 x^4 - 4s^4 ax^3 - \frac{2s^4}{2} x^2 + 1 = 0$. Which in numbers reduced will give the cosine of the hour.

The proposer's answer.

Let $\sqrt{1-aa} = \text{fine of } Z \odot \text{ or } P \odot$, $b = \text{fine of } ZP \text{ comp. lat. } 60^\circ 38'$, $n = \text{fine lat. } 29^\circ 22'$, $a = \text{fine of the altitude}$.

As $\sqrt{1-aa} : a :: b : \frac{ab}{\sqrt{1-aa}} = \text{fine } \angle Z \odot P$ and

$1 - \frac{b^2 a^2}{1-aa} = \text{the square of its cosine; } 1-aa : 1 :: 1-n$

$: \frac{1-n}{1-aa} = \text{versed fine } \angle Z \odot P$, and $\frac{n-aa}{1-aa} = \text{cosine}$

$\angle Z \odot P$. Hence $\frac{nn - 2naa + a^4}{1-aa} = 1-aa - a^2 b^2$.

Reduced we have $a = .7492411 = \text{fine of } 48^\circ 33' = \text{to the altitude and latitude of Perseus's right side}$.

VII. QUES-

* VI. QUESTION 157.

In this question, is given ZP , the $\angle Z = \angle P = \text{comp. } \odot Z \text{ or } \odot P$, the triangle being isosceles. Then

Supposing a perpendicular demitted from \odot upon and bisecting ZP , and thereby dividing $\odot ZP$ into two equal right-angled triangles; put $a = \text{the tangent of the base of each or of half } PZ \text{ the given colatitude}$, and $x = \text{fine of the hypotenuse } \odot P \text{ or } \odot Z = \text{cos. } \angle P \text{ or } Z$; then, by right angled triangles, (radius =) $1 : x$

$:: \frac{x}{\sqrt{1-x^2}} (= \text{tang. } \angle P \text{ or } Z) : \frac{x^2}{\sqrt{1-x^2}} = a$; hence x^4

$= a^2 - a^2 x^2$, and $x = \sqrt{a\sqrt{\frac{1}{4}a^2 + 1} - \frac{1}{2}a^2} = \text{the cosine of the declination}$.

* VII. QUESTION 158 answer'd by Mr. J. Fearnside.

Let $DC = m$, $AB = b$, $AH = c$, $HB = a$, $\sin. \angle D = s$, its $\cos. = l$, $\sin. \angle CAH = r$, $\sin. HBA = u$, its $\cos. = t$, and $BF = x$.

Then will $\sin. \angle F = \frac{b}{x}$, and its $\cos. =$

$$\sqrt{\frac{xx - bb}{xx}}; \sin. C = \frac{bl}{x} + s \sqrt{\frac{xx - bb}{xx}};$$

$$HC = \frac{cr}{\frac{bl}{x} + s \sqrt{\frac{xx - bb}{xx}}}; \sin. HBD =$$

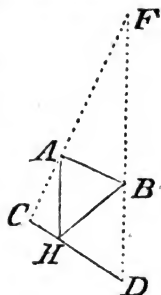
$$\frac{ub}{x} + t \sqrt{\frac{xx - bb}{xx}}; \text{ and } HD =$$

$$\frac{uba}{sx} + \frac{ta}{s} \sqrt{\frac{xx - bb}{xx}}. \text{ Whence this}$$

$$\text{equation } \frac{cr}{\frac{bl}{x} + s \sqrt{\frac{xx - bb}{xx}}} + \frac{aub}{sx} + \frac{ta}{s} \sqrt{\frac{xx - bb}{xx}} = m.$$

Which reduced gives $x = 233.10474$. Therefore $DF = 412.5$, $CF = 427.4$, and the area 1 ac. 1 r. 20 p.

This question being unlimited, as not determined on which wall Bacchus or Apollo stands, will admit of another answer.



VIII. QUES.

* VII. QUESTION 158.

In this question it is required, about a given triangle to circumscribe another triangle such, that one of its angles, and one of the sides about that angle, shall be each of a given magnitude; and the side opposite to the given angle perpendicular to a side of the given inscribed triangle.

And hence if upon the given line BH be described the segment of a circle capable of containing the given angle D , the problem is reduced to this: To apply a line CD of a given length between the circumference of that circle and the line CF given in position, and so as to pass through the given point H .

* VIII. QUESTION 159 answer'd by Mr. Anderson.

Given the latitude, the sun's declination, and the sun's heat, as the sine of his altitude and continuance above the horizon (viz. as their product) for so I take it, and was so inform'd by E. Stone, who propos'd the same question in his preface to d' Hospital's fluxions.

Lemma

* VIII. QUESTION 159.

Put s and c = the sine and cosine of PZ , d and e = sine and cosine of $P\odot$, m = the semi-diurnal arc, x = the hour arc or $\angle P$, y = its sine, and z = sine of the altitude or cosine of $Z\odot$.

Then $mz + xz$ = a maximum, per question,

$$\text{or } m\dot{z} + x\dot{z} + \dot{x}z = 0.$$

$$\text{But } z = ce + ds\sqrt{1-y^2}, \text{ or } \dot{z} = \frac{-dsy\dot{y}}{\sqrt{1-y^2}}; \text{ and}$$

$$\dot{x} = \frac{\dot{y}}{\sqrt{1-y^2}}.$$

$$\text{Wherefore } \frac{-dsmy\dot{y}}{\sqrt{1-y^2}} - \frac{dsxy\dot{y}}{\sqrt{1-y^2}} + ds\dot{y} + \frac{ce\dot{y}}{\sqrt{1-y^2}} = 0,$$

$$\text{or } ce - dsmy - dsxy + ds\sqrt{1-y^2} = 0,$$

$$\text{and hence } x = \frac{ce - dsmy + ds\sqrt{1-y^2}}{dsy}.$$

Now this equation may be resolved after several different manners. One method is to substitute in it the value of x in terms of y in an infinite series; and this will be like the two original solutions: Or a finite approximate value of x in terms of y may be substituted for it, and then the resulting equation will be finite: Or some method may be used for approximating to the values of x and y immediately from the equation as it stands above, which will be easiest and soonest done; and the best method for that purpose seems to be this; by a few trials find $y = .5$ nearly, which substituted in the above form, a near value of x will be found; from a table of sines, to this value of x take the correspondent value of y , which written in the above form again, there will be had a nearer value of x ; and so on as far as necessary.

Lemma $c + d a x \times s =$ sine sun's altitude, as in question 157. But $x + \frac{1}{6}x^3 + \frac{3}{40}x^5 + \frac{5}{112}x^7 + \&c.$ is the arch belonging to x , and $b - x - \frac{1}{6}x^3 - \frac{3}{40}x^5 - \frac{5}{112}x^7 \&c.$ (putting $b = \frac{1}{4}$ of the circumference) is the complement of it, and therefore the hour from noon: Put $r =$ the time (viz. the length of the arch of the equinoctial) pass'd over from sun-rising to noon; Now it is manifest the aforefaid phænomenon will not happen before the sun's arrival at the meridian, therefore $r + b - x - \frac{1}{6}x^3 - \frac{3}{40}x^5 - \frac{5}{112}x^7 - \&c.$ is the sun's continuance above the horizon, and this multiplied by $se + s d a x$ the line of the altitude, and thrown into fluxions and reduced gives $2 s d a x + \frac{1}{2} s e x^2 + \frac{1}{2} s d a x^3 + \frac{3}{8} s e x^4 + \frac{9}{80} s d a x^5 + \frac{5}{16} s e x^6 + \frac{5}{14} s d a x^7 + \&c. = s d a r + s d a b - s e - m.$ And therefore $x = \frac{m}{2 s d a} - \frac{m^2}{2 s e \times 2 s d a} + \frac{3 e e s - 4 d a}{4 d a} \times \frac{m^3}{2 s d a} - \&c.$

The proposer's answer.

Let $m =$ the rectangle of the sine com. lat. and co-declination, $p =$ sun's alt. at 6, $n =$ the length of the semi-diurnal arch, and z the length of the arch from noon. The cosine of the hour angle from noon is $= 1 - \frac{z z}{2} + \frac{z^4}{24} - \frac{z^6}{720} \&c.$ and, putting $m + p = a$, the sine of the sun's altitude will be $= a - \frac{m z z}{2} + \frac{m z^4}{24} - \frac{m z^6}{720}, \&c.$ Which multiplied by $n + z$, and thrown into fluxions, $\&c.$ gives $m n z + \frac{3 m}{2} z^2 - \frac{m n}{6} z^3 - \frac{5 m}{24} z^4 + \&c.$ Revers'd z will be $= .50614$ (the radius being 1) consequently the hour is 1 h. 56' afternoon.

Several have attempted the solution of this question; but differ widely from the author, viz. Mr. *Grimmett* and Mr. *Bulman* make the island's compass 657 leagues; Mr. *Ommanney* 50 leagues; others 26 leagues: And not knowing after what method the author proceeded for his answer, or whether there be not some mistake in the manuscript of this question; I shall wave giving those other methods till a better opportunity shall set this matter right.

XI. QUESTION 162 *answer'd by the proposer Mr. Mason.*

$$A = 404 : B = 465.$$

Mr. Robert Fearnside's answer.

Let $2y$ = sum of the aliquot parts in A ; and $3z$ = sum of the aliquot parts in B : Then $3y$ will be = second number B ; and $4z = A$. Now $1 + 2 + 4 + z + 2z = 2y$; and $1 + 3 + y = 3z = 2y - 7$. Consequently the first number A will be found to be 20, and $B = 33$.

For $1 + 2 + 4 + 5 + 10$ is $= \frac{2}{3}B$; and $1 + 3 + 11$ is $= \frac{3}{4}A$.

Mr. Grimmett's answer.

It is supposed that $\frac{3}{4}$ of A is an integer, because the sum of the aliquot parts in B is = to it; and likewise $\frac{2}{3}$ of B is an integer for the same reason; therefore the number A must be a multiple of 4; and the number B a multiple of 3. Make therefore $A = 4a$; its aliquot parts are $2a, a, 4, 2, 1$ the sum of which is $3a + 7$. Put also $B = 3e$; the sum of the aliquot parts of which is $e + 4$; and per question $3a + 7 = 2e$ ($= \frac{2}{3}B$); also $e + 4 = 3a$ ($= \frac{3}{4}A$). Whence a is found = 5; and $e = 11$. Consequently $4a = 20$ = the number A ; and $3e = 33 = B$.

The Prize Question answered by Mr. Rob. Fearnside.

Let $x^6 = A, y^6 = B, z^6 = C$; then $x^6 + \frac{x^6}{5} = x^6 - z^6$;
consequently $x = z\sqrt[6]{\frac{10}{4}}$ and $x = y\sqrt[6]{\frac{10}{6}}$: Now by Ward's
Theorem,

Theorem, p. 271, we shall have (putting $r = \sqrt[3]{\frac{2}{5}}m = 1.50363$, $n = 1.06$) $\frac{nm^2 \sqrt[3]{y^3} - m^2 x \sqrt[3]{y^3}}{m-1} = 22xx = \text{rent}$

whence by substitution, &c. $x^2 = \frac{m-1}{n-1} \times \frac{r}{sm^2} = 3.5316$.

Then $x^6 = A = 44.047579$, $B = 26.423547$, and $C = 17.61903$.*

The

* The PRIZE QUESTION.

In this question, for determining the three quantities, x, y, z , there are given the two equations $x + y = z$, and $y + \frac{z}{5} = x$: And the third equation is to be made out from these following conditions, viz. that \sqrt{xz} is the present value of a yearly rent, which is expressed by $\sqrt[3]{yz}$, to continue for 7 years, but the first payment not to become due till the end of the 8th year; the interest of money being reckoned at 6 per cent.

From the two first equations we easily find $x = \frac{3z}{5}$, and $y = \frac{2z}{5}$; consequently the yearly rent becomes $\sqrt[3]{\frac{2z^2}{5}}$, and the present of it $\sqrt[3]{\frac{3z^2}{5}}$ or $z\sqrt[3]{\frac{3}{5}}$. But by any calculated table of reversions at 6 per cent. it appears that the present worth of one pound due 8 years hence is .6174, the present value due 9 years hence .5919, the same for 10 years .5584, for 11 years .5268, for 12 years .4970, for 13 years .4688, and for 14 years .4423; the sum of these is 3.7126 which is the present value of 1 for those 7 years, and consequently $3.7126 \sqrt[3]{\frac{2z^2}{5}} = \text{the present value of } \sqrt[3]{\frac{12z^2}{5}}$ annuity for the same time, and which must be equal to $z\sqrt[3]{\frac{3}{5}}$, that is $3.7126 \sqrt[3]{\frac{2z^2}{5}} = z\sqrt[3]{\frac{3}{5}}$; hence then z is $= 3.7126 \times \frac{2}{3} \sqrt[3]{\frac{5}{3}} = 3.7126 \times \frac{2\sqrt[3]{15}}{9} = 44.042$. Consequently $x = \frac{3z}{5} = 26.4252$, and $y = \frac{2z}{5} = 17.6168$.

The same otherwise answered.

Let	{	1	$a =$ the cash to be divided,
		2	$b =$ B's part,
		3	$c =$ C's part.
Then		4	$b - \frac{a}{5} = c$ per question
$2 + 4$		5	$2b - \frac{a}{5} = a.$
$5 \times 5 + a$		6	$10b = 6a.$
$6 \div 6$		7	$\frac{10b}{6} = a.$
$7 \div 5$		8	$\frac{10b}{30} = \frac{b}{3} = \frac{a}{5}.$
$2 - 8$		9	$\frac{3b - b}{3} = \frac{2b}{3} = C's \text{ part}.$
7×2		10	$\frac{10bb}{6} =$ the square of the purchase.
7×9		11	$\frac{10bb}{9} =$ the cube of the yearly rent.
Substit.		12	$m^2 = \frac{10}{6}$
Then		14	$mmbb = \frac{10bb}{6}$
14 extr.		15	$mb =$ the purchase (which per Ward, p. 246 theo. 1.)
Will be		16	$rtmb + mb =$ the value at the time of purchase, which per 2d theor. Ward, p. 249.
Will be		17	$\frac{2rtmb + 2mb}{ttr - tr + 2t} = u$ { put $2tm = x$; and $2m = z$; and $ttr - tr + 2t = d.$
Then		18	$\frac{xb + zb}{d} = u.$
18 cub.		19	$\frac{x^3b^3 + 3xxzb^3 + 3xzzb^3 + 2zb^3}{d^3} = \frac{10bb}{9}$
19 $\times 8 \div$		20	$b = \frac{\frac{1}{18}ddd}{x^3 + 3xxz + 3xzz + z^3} = 101'730562$
			C's part = 67'820375
			Cash to be divided = 169'550937
			The annuity or income = 22'577929

The prize of 10 diaries fell to Mr. Rob. Fearnside.

End of the First Volume.

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